THE FOUNDRY

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MOLDING LARGE CAST STEEL LADLES

Description of the molding and casting practice-- The large core and method of assembling

THE Prime Steel Co., Milwaukee, is now casting what are believed to be the largest slag ladles ever manufactured. Each ladle is a solid steel casting and in its production some rather difficult problems in molding and coremaking were successfully solved. The ladles will be mounted on trucks in the usual manner; each ladle weighs 20,000 pounds and is 10 feet, 5 inches in diameter across the top and 8 feet, 6 inches deep inside, having a capacity of 300 cubic feet. With the exception of the rim, the metal at the top is 1¾ inches thick, increasing to 2¾ inches at the bottom, which is bowl-shaped.

The mold is made in a pit, the ladle being cast right side up. The conical core, which forms the inside of the mold, is suspended from the cope. A cross-section of the mold with the core in place is shown in Fig. 5. Fig. 1 shows the cope with the suspended core beneath. In making the mold the sand is first swept out, forming a cavity exactly the size of the inside of the ladle, as represented by the line, *abc*, Fig. 5. The core is then assembled in this cavity and the cope is finished. The cope with the core is then withdrawn and the mold is swept out again, this time to a size corresponding with the outside of the ladle, as indicated by the line, *def*, Fig. 5. The cope and core are then finally replaced, and the mold is secured by weights, ready for casting.

The core, which is one of the most interesting features of the mold, is built-up and consists of 16 separate pieces. Its general construction is indicated in Figs. 1 and 5. Referring to these illustrations, it will be seen that it consists of a solid, bowl-shaped bottom piece, *P*, Fig. 5, which is made exactly the shape of the bottom of the ladle, with 15 wedge-shaped slab cores resting on the bottom piece and forming the conical, inside surface of the mold. The whole core is suspended by rods from the cope. Four 1¼-inch rods carry the bottom core and each slab core is also provided with three suspension rods, two on the side and one on the top, as indicated in Fig. 5. The slabs, Fig. 2, are each seven inches thick, 6 feet 3 inches in length,

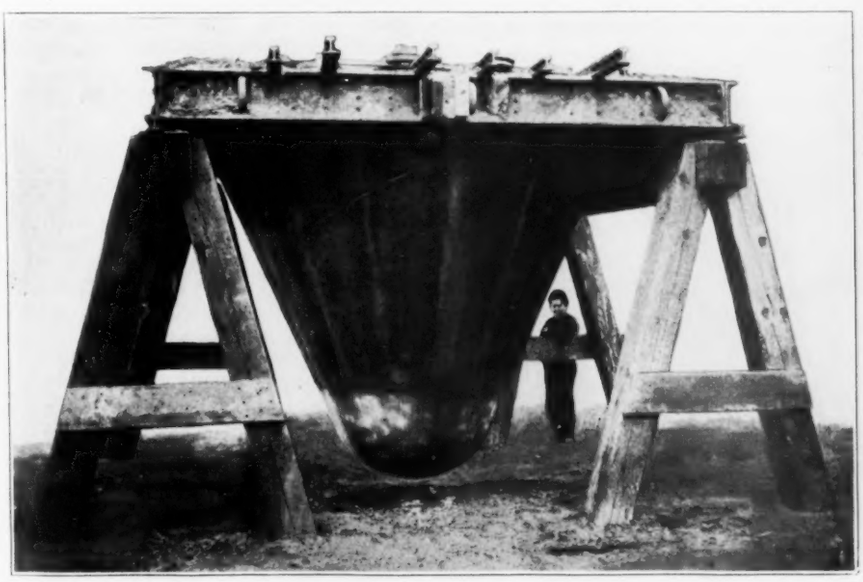


FIG. 1—THE COPE WITH THE CORE ASSEMBLED BEFORE BEING PLACED IN THE MOLD

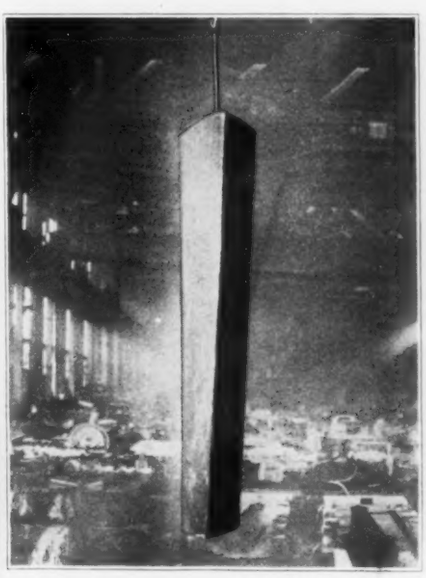


FIG. 2—A CONICAL CORE SLAB

FIG. 3—THE LADLES AFTER SHAKING-OUT, SHOWING THE POURING GATES AND RISERS

before the cope is replaced. Only one pouring gate is used, as shown in Fig. 3. It consists of a riser, about three inches in diameter, extending vertically into the sand and provided with three feeding gates, one at the top, one about one-third and one about two-thirds of the distance down the side of the ladle. The gates are about 2 x 4 inches in cross-section. Six small sink heads are spaced equi-distantly around the top of the ladle. The mold was made in the manner described in order to be certain that there would be no cracks or checks in the finished product.

The metal is poured from a 20-ton ladle and is run into the mold as hot as possible. Ordinary steel is used,

26 inches wide across the top and 14 inches wide at the bottom. They are very strongly made, being heavily reinforced with steel rods and provided with suitable eyes to receive the suspension wires. The bottom piece is also strongly reinforced. Several cast steel arbors, *A*, Fig 5, are inserted in the hollow, conical part of the core to resist crushing stresses.

The cope flask from which this core is suspended is about 15 feet square and 18 inches high, made of cast steel with steel cross-bars. Its sides are similar in cross-section to a rolled channel. Steel rails are laid across the top of the cope and the washers under the suspension rod nuts rest on these rails, thus distributing the weight of the core. The cope and core together weigh about 20 tons. Great care is taken that the core shall be stiff and able to resist considerable crushing stress and also the upward pressure of the fluid metal in the mold.

The inside of the mold is skin-dried

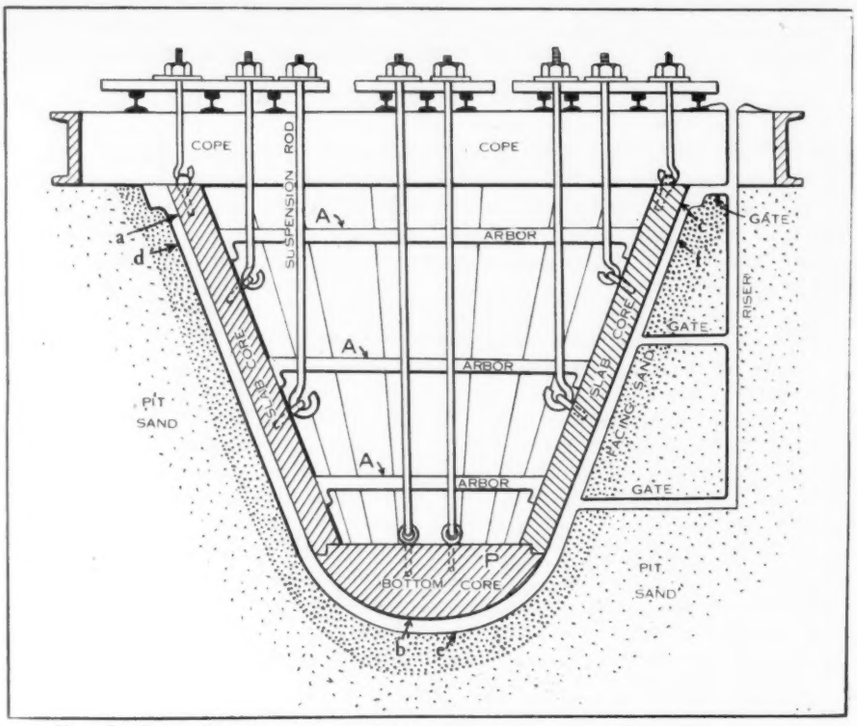


FIG. 5—CROSS-SECTION OF THE LADLE MOLD, SHOWING CORE CONSTRUCTION

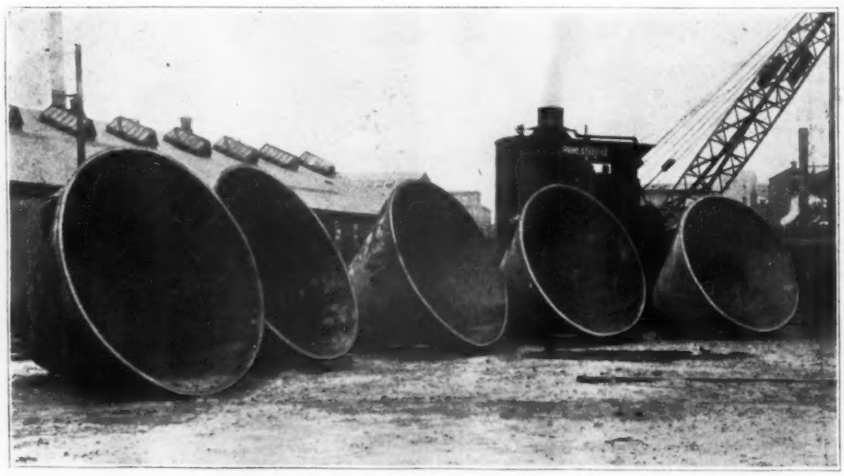


FIG. 4—FINISHED LADLES BEFORE SHIPMENT

melted in an acid, oil-burning open-hearth furnace.

After the casting has cooled it is shaken out of the mold by the crane, as shown in Fig. 3. The gates and heads are cut off and the interior and exterior of the ladle are finished with a portable emery grinder.

A white alloy resembling German silver, known as manganese argentan, consists of the following: Copper, 55 per cent; 30 per cent manganese-copper, 15 pounds, and zinc, 15 pounds. Melt the copper and nickel together and add the manganese-copper. When thoroughly liquid add two ounces of aluminum, lastly the zinc.

COMPARATIVE FOUNDRY COST RECORDS

Accurate reports of defective castings--Chart of casting production costs--Record of miscellaneous operations

By G. E. Andres

IN EVERY foundry an accurate record should be available, not only of the number of defective castings produced, but of the causes that lead to these losses. In Fig. 1 is shown a report card which will prove a great aid to the foreman in ascertaining the number of defective castings produced by each molder, as well as the number broken. Frequently, the foundry foreman is expected to produce results without the proper data whereby he could improve the work of the shop. Casting losses are an important item that should receive careful consideration and the more information that can be imparted to the foreman on this subject the more rapidly he can improve the efficiency of the molding department. Although it is important that details of shop operations be recorded in the office, yet these records are of little value unless distributed among the department heads who are directly responsible for results. Records held in the office are of little value to the foreman in the shop.

Defective Casting Report.

It might be advisable for every foundryman to consider the following questions: Are you giving the foreman a fair opportunity to improve his work? What have you done to assist him? Have you directed his attention to certain patterns which are in need of repairs? Have you pointed out the men in the shop who are incapable and whose records are below the average? It is safe to say that few foundrymen assist their foreman in this way. Only too frequently the foreman has no knowledge of shop operations from the office records until the end of the month.

In a shop engaged largely on a standard line of work it is fair to assume that the foreman handles from 100 to 200 patterns per month. In addition, he must superintend the work of the shop employes, scheme new rigging, oversee the pouring and his other duties are almost too numerous to mention. It is almost impossible for the foreman to pick out all of the patterns which need repairs and for this reason he should be given a daily report of the number of defective castings which will give him a clue to the patterns which need attention. Frequently, by calling the foreman's attention to a certain pattern, new rigging can be devised and molding methods can be simplified. In this way the production costs will be greatly reduced. It is not uncommon to improve molding methods which will not only reduce the percentage of losses, but will likewise increase the output. If the foreman constantly receives information regarding defective work he will invariably apply himself and will devise schemes to reduce these losses. As new patterns are received, he will make comparisons with similar patterns previously made and thereby the new pattern can be properly molded in the foundry and the expense of experimenting with the pattern is saved.

DEFECTIVE CASTING REPORT

DEPT. "A"

J. Smith. FOREMAN HEAT OF 3/11/10

PATT. NO.	MADE BY CHECK	PIECES CAST	NUMBER BAD	NUMBER BROKEN
X-77	62	10	2	—
Z-110	179	18	10	—
S-42	99	6	1	—
T-3254	32	16	6	—
X-99	84	22	4	—
T-2119	52	8	6	1
S-770	61	14	2	—
Z-952	22	32	3	—
X-372	66	67	4	—
T-3799	34	20	12	3
Z-84	12	10	1	—
T-2419	10	16	2	—

PLEASE ATTEND TO

Patt. Z-110

" T-2119

" T-3799

FIG. 1—DEFECTIVE CASTING REPORT SHEET

On the defective casting report sheet a column is provided for the pattern number, the check number of the molder, number of pieces cast, bad castings and the number of castings broken. This report can be easily filled in as it is copied from the daily casting report which contains all of the information for this card. Defective castings are divided into two divisions, namely, pieces bad and number broken. The former sub-division covers the number of castings lost as a result of poor workmanship or pattern design, and indicates that the foreman's attention is required, particularly if the losses are heavy. Number broken include such castings as may have been properly made, but are broken when shaken out of the sand, or in one of the subsequent cleaning operations. Castings broken in this way are, of course, not the fault of the molder, nor can they be considered defective castings, as they are lost as a result of carelessness on the part of those handling the castings after they have been poured. The superintendent or general foreman should always receive a copy of this defective report to enable him to check patterns against the various departments and this will enable him to note improvements, if any result.

Molders' Report.

This report will also enable the foreman to notify the molders of the number of defective castings made. A small slip is handed each molder, as shown in Fig. 3, on which is entered the pattern number, number of pieces lost and the date of the heat. For example, it will be noted from Fig. 1 that the molder holding check No. 62 made ten castings from pattern X77. The next day a report of defective castings, Fig. 3, is handed to this molder, which notifies him that two of the ten castings were defective. If he is working on a piecework basis and is paid 40 cents for each casting made, his earnings for that day will total $3.20 in place of $4.00, which he would have received if all the castings would have have passed as satisfactory. If the molder has any doubts as to whether he has lost these two castings and desires to note molding errors, he can do so by inspecting the castings on the scrap pile and in this way many improvements can be brought about. It is advisable to invite the molders

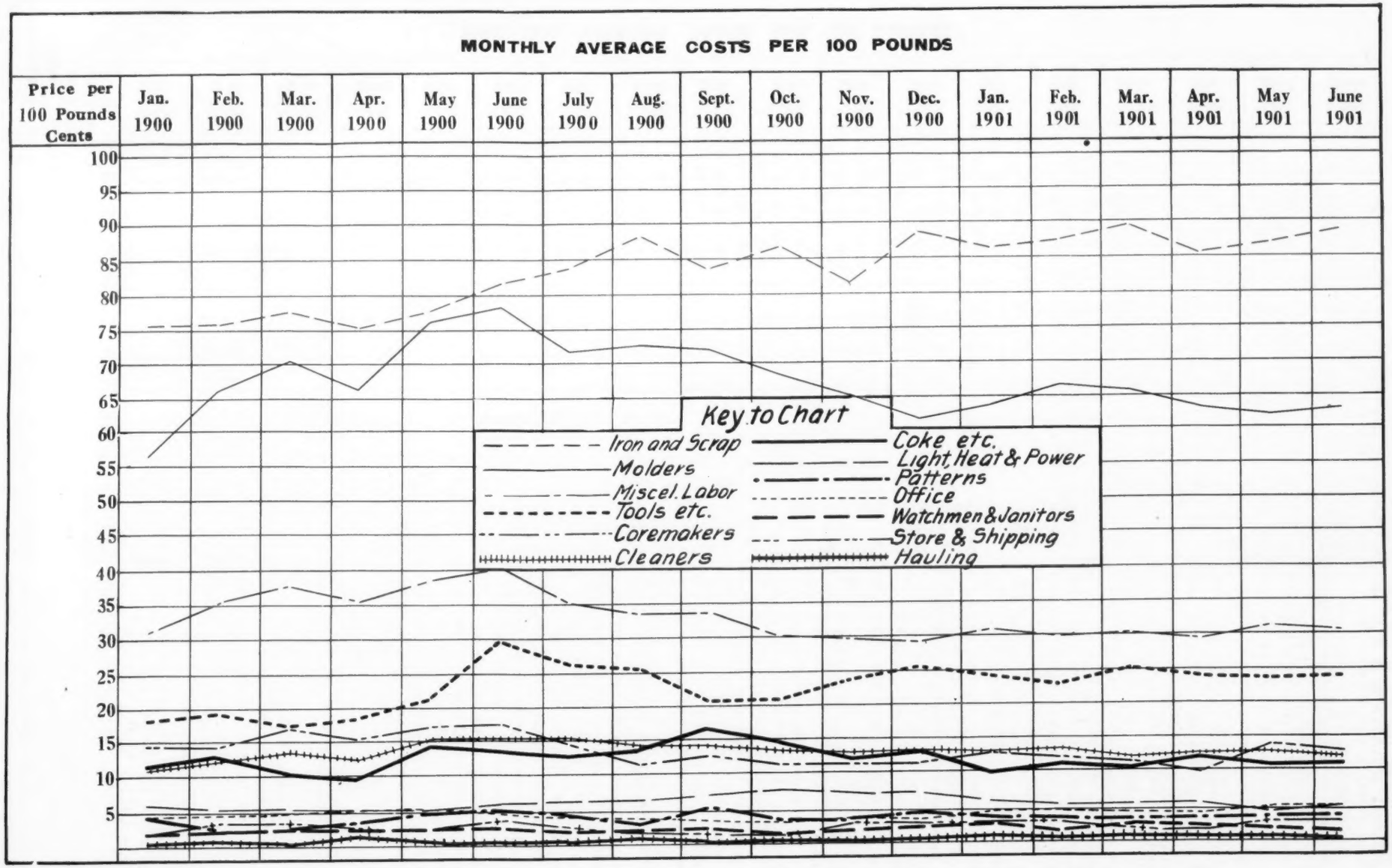


FIG. 2—CHART, SHOWING THE AVERAGE MONTHLY COST PER 100 POUNDS OF GOOD CASTINGS PRODUCED

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication.

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

NOTES FOR THE BRASS FOUNDRYMAN.

London Tin Contract.

To make it more difficult to manipulate the tin market, the London metal exchange has adopted new rules governing standard tin contracts. The paragraph governing the sampling of tin incorporated in these specifications, follows:

Sampling Tin.

Samples are taken by drilling through one pig from each lot of 1,120 pounds. Three samples are taken from the drillings, and one is sent to each of two assayers, and in case they fail to agree, the third sample is to be sent to a third assayer, chosen by the other two, whose report is considered final.

Tin Analyses.

The standard analyses of some of the more important brands of tin affected by the new arrangement follow:

	Tin, per cent.	Antimony, per cent.	Arsenic, per cent.	Lead, per cent.	Bismuth, per cent.	Copper, per cent.	Iron, per cent.	Sulphur, per cent.
Billiton tin....	99.96	0.006	.....	.....	.....	0.023	.....	.....
Banca tin.....	99.95	0.007	.....	trace	.....	0.018	0.045	trace
Penang tin....	99.94	trace	0.013	trace	.....	0.016	0.028	0.04
Singapore tin.	99.87	0.008	0.045	0.034	0.003	0.052	0.003	0.005
Mt. Bischoff..	99.80	0.015	0.063	0.037	0.005	0.035	0.042	0.008
Chinese No. 1.	99.34	0.031	0.040	0.434	0.007	0.052	0.10	0.072
Chinese No. 2.	98.66	0.039	0.035	1.035	0.012	0.134	0.014	0.058
Chinese No. 3.	95.28	0.381	0.050	3.995	0.020	0.106	0.026	0.116

These analyses show that the finest tin is Billiton, and then follow Banca and Penang in the order named. Singapore, while not so pure as the three preceding brands, is still a high grade tin. The Chinese brands contain considerable lead, but not enough to be harmful for many of the uses of the brassfounder.

USEFUL INFORMATION FOR THE FOUNDRYMAN.

In the following table are given the weights, specific gravities and the melting points of various metals and alloys, with the chemical symbols as determined by various authorities:

Metal	Chemical symbol	cubic foot in pounds Weight per	Specific gravity	point, deg. Fahr. Melting
Aluminum, cast.....	Al	160	2.56	1,225
Aluminum bronze.....	..,	475	7.68	1,908
Antimony	Sb	418	6.71	450
Babbitt metal.....	...	454	7.31	....
Bell metal.....	...	501	8.06	1,782
Bismuth	Bi	617	9.90	516
Brass, cast.....	...	505	8.10	1,300
Bronze	...	534	8.56	1,890
Copper	Cu	554	8.60	1,929
Cadmium	Cd	536.85	8.64	612
Calcium	Ca	98.01	1.41	1,436
German silver	...	516	...	1,940
Gun metal, 9 Cu, 1 Sn....	....	531	8.50	1,850
Iron, cast	...	450.08	7.2	1,967
Iron, wrought.....	Fe	476	7.55	2,732
Lead	Pb	712	11.419	618
Magnesium	Mg	108.62	1.74	1,200
Manganese	Mn	499.40	8.00	2,273
Mercury	Hg	849	13.596	Liquid
Nickel	Ni	516	8.67	2,642
Phosphor bronze	...	537	8.60	1,885
Platinum	Pt	1,342	21.522	3,227
Potassium	K	54.31	0.87	....
Silver	Ag	655	10.505	1,733
Steel	...	489.6	7.854	2,687
Tin	Sn	462	7.409	450
Tobin bronze.....	...	523.06	8.379	1,340
Zinc	Zn	428	6.86	779

To convert the melting points from degrees Fahr. to degrees Cent., subtract 32, divide by 9 and multiply by 5.

to inspect their defective work, as this frequently will prove an incentive that will lead to a clean report sheet for the following day.

By notifying the molders each day of their number of losses, many arguments which might develop on the regular pay day are obviated. Occasionally, a mold is perfectly made, but the loss of the casting is due to the blowing of the core and, therefore, this loss should be charged to the core department. The molder, after inspecting the casting, notifies the foreman that the loss should not be charged to him, and after the foreman's personal inspection, the molder is allowed the cost of making one mold. It will be noted in Fig. 3 that the molder holding check No. 62 was credited with one casting of the two lost. This slip is then returned to the office and the molder is credited with 40 cents which was the piecework price of molding one casting. By checking defective castings daily all differences with the molders are immediately adjusted and the result will be that the men will

DEFECTIVE CASTINGS

HEAT - 3/11/10. CHECK - 62.

2 Pieces, Pat. X 77

ALLOW - 1. J. Smuth - FOREMAN

FIG. 3—DEFECTIVE REPORT SLIP FURNISHED THE MOLDER

be better satisfied. It also might be added that with the elimination of pay-day arguments, particularly with men on a piecework basis, the accounting department is relieved of much difficulty.

In Fig. 4 is shown a report on which the materials used in the foundry during each month of the year are totaled. In addition to the total annual consumption, the monthly and daily averages are also given. Columns are provided for all the raw materials, such as pig iron, scrap, sand, coal, coke, limestone, charcoal and fire clay. This report furnishes the superintendent all of the necessary information regarding raw material consumption and enables him to make comparisons from day to day and month to month.

Comparative Cost Report.

A comparative cost report per 100 pounds of good castings produced is shown in Fig. 5. Columns are provided for the labor cost of molding, coremaking, chipping and grinding, miscellaneous labor, cost of iron, coke and foundry supplies, hauling, miscellaneous charges including repairs to tools and buildings, watchman and janitor service, storing and shipping patterns, office force and light, heat and power. In the last column the total cost per 100 pounds of castings is entered. By making casting comparisons from month to month, increases and decreases will be found which necessarily should be explained. We will first compare the items of molding, coremaking, chipping and grinding, which are considered the productive labor of the foundry, and some of the practical reasons for increases and decreases in these items will be outlined. A comparison of the bad casting percentage with that of the previous month will undoubtedly disclose a good reason for an increase in cost, as a one per cent increase in this item is equivalent to a decrease in the output of one per cent. This would not only increase the cost of productive labor, but would also increase all other items entered on this report. The average weight of castings made also has a tendency to increase the average cost. If the average weight of castings one month is 50 pounds, and if this average drops to 40 pounds the succeeding month, an increase in the cost of the lighter work is naturally expected. The average rate paid per hour is also an important item which must not be overlooked when increased production costs are being considered.

SUMMARIES OF MATERIALS USED

MONTH	YEAR	PIG IRON POUNDS	SCRAP POUNDS	TOTAL IRON MELTED POUNDS	SAND POUNDS	COAL NET TONS	72-HOUR COKE NET TONS	48-HOUR COKE NET TONS	LIME-STONE NET TONS	CHARCOAL POUNDS	FIRECLAY POUNDS
JAN.	1909	1,396,150	1,355,100	2,751,250	1,196,062	167.71	118.40	31.40	34.97	36,350	42,430
FEB.	"	1,277,170	1,331,700	2,608,870	1,203,065	139.31	200.06	61.15	28.93	62,720	90,230
MAR.	"	1,156,850	1,091,600	2,248,450	987,730	130.21	149.17	16.20	24.34	37,980	91,070
APR.	"	1,323,480	1,326,620	2,650,100	927,815	167.15	184.35	44.07	33.68	31,470	110,100
MAY	"	1,404,300	1,233,030	2,637,330	1,416,940	230.45	234.17	44.01	20.20	69,480	55,000
JUNE	"	1,775,580	1,207,630	2,983,210	1,467,380	186.60	214.63	36.06	35.10	12,400	66,820
JULY	"	1,451,480	1,286,680	2,738,160	1,593,270	228.51	196.32	47.99	23.25	66,900	42,240
AUG.	"	1,348,820	1,031,850	2,380,670	1,360,530	203.45	179.74	31.66	15.58	47,490	101,000
SEPT.	"	1,567,300	924,900	2,492,200	1,837,205	205.05	187.85	86.29	15.60	30,520	50,290
OCT.	"	1,730,490	1,122,670	2,853,160	1,337,982	192.24	212.18	31.80	16.15	94,080	83,090
NOV.	"	1,390,540	883,620	2,274,160	1,162,810	299.44	267.16	14.62	23.40	30,330	44,280
DEC.	"	1,461,240	1,038,200	2,499,440	1,007,760	250.26	258.47	12.32	19.69	19,630	58,640
GRAND TOTAL		17,283,400	13,833,600	31,117,000	15,498,549	2400.38	2402.50	457.57	290.89	539,350	835,240
MONTHLY AVERAGE		1,440,283	1,152,800	2,593,083	1,291,545	200.03	200.21	38.13	24.24	44,946	69,603
DAILY AVERAGE		58,193	46,578	104,771	52,184	8.08	8.09	1.54	.98	1,816	2,812

FIG. 4—RECORD OF MATERIALS USED

MONTHLY COMPARATIVE COSTS PER 100 POUNDS
COST IN CENTS

MONTH	YEAR	MOLDERS	CORE-MAKERS	CHIPPERS AND GRINDERS	MISCEL. LABOR	IRON	COKE AND FOUNDRY SUPPLIES	HAULING	MISCEL. CHARGES REPAIRS TO TOOLS AND BUILDING	WATCHMEN AND JANITORS	STORE AND SHIPPING	PATTERNS	OFFICE	LIGHT HEAT POWER	TOTAL COST DOLLARS
JAN.	1909	56.5	14.6	11	31.1	754	11.4	.6	18.2	2	2	4.1	4.2	6.1	2.372
FEB.	"	66	14.5	12.1	35.1	758	12.9	.7	19.3	2.1	3.1	2.5	4.4	5.5	2.540
MAR.	"	70.7	17.5	13.5	37.8	77.1	10.6	.4	17.6	2.4	3.1	2.8	4.3	5.6	2.639
APR.	"	66.1	15.3	12.4	35.3	753	9.8	1.6	18.7	2.2	2.4	3.5	5.2	5.1	2.529
MAY	"	76	17.1	15.2	38.6	778	14.2	.9	21.3	2.4	2.5	5.8	5.3	6.4	2.835
JUNE	"	78.3	17.3	15.3	40.1	813	13.2	.8	29.9	2.4	3.5	5.3	4.9	6.7	2.950
JULY	"	71.2	14.3	15.2	35.1	838	12.6	.7	26.4	2	2.4	4.5	4.1	6.5	2.781
AUG.	"	72.8	11.4	14.2	33.5	881	13.5	1	25.5	2.2	1.9	2.8	4.2	7.1	2.782
SEPT.	"	71.9	12.9	14.1	33.8	83.1	16.7	.6	20.6	2.2	1.9	5.4	3.6	8	2.748
OCT.	"	68	11.3	13.7	30.2	869	14.6	.6	20.9	1.9	1.2	3.7	3.5	7.2	2.637
NOV.	"	65.1	11.5	13	29.5	81.3	12	.5	23.6	2	3	3.4	3.8	7.1	2.553
DEC.	"	61.3	11.4	13.3	29.1	88.8	13.7	.5	25.3	2.1	2.5	4.3	3.6	6	2.619
YEARLY AVERAGE PER 100 POUNDS		68.4	14	13.4	34	813	12.9	.7	22.2	2.1	2.5	4.1	4.3	6.4	2.663

FIG. 5—MONTHLY COMPARATIVE COST REPORT PER 100 POUNDS OF GOOD CASTINGS PRODUCED

The item of miscellaneous charges includes such labor as cupola tenders, department labor, unloading material from cars, cranemen, blower room employes and men handling patterns. Causes for increases in the items constituting this division will undoubtedly vary from month to month, owing to the miscellaneous line of work included and the reasons can best be explained by the general foreman who is constantly in touch with these departments.

For example, during the month it might be found that the cupola men are hauling iron which was placed in the extreme corner of the yard when received, thereby requiring a longer time to haul it to the furnaces or cupolas and this necessitated the employment of extra men. Furthermore, a large stock of material might have been received during the month, such as sand, pig iron, scrap, fire clay, limestone, etc., which would necessitate extra labor for unloading the cars. Furthermore, the tonnage might have decreased, yet it is probable that all of the cranemen will be required at a certain time of the day and this will prevent a reduction in this force.

The column in which is entered the cost of iron, includes both pig iron and scrap, and in the adjoining column is entered the cost of coke, core material and foundry supplies, which includes all other materials required in the production of castings, such as sand, plumbago, coke, limestone, charcoal, fire clay, parting compounds, etc. These items cannot very easily be controlled as they are governed by the prices that must be paid for them. The cost of iron and scrap will vary according to the mixtures used. The cost of hauling, storing and shipping, light, heat and power, are largely controlled by the amount of work that is being done, and the greater the output the lower the average cost, particularly of office help, watchmen, janitors, etc. Under the item of hauling it will be found that repairs will have to be made from time to time, although the cost of watchmen and janitor service will not vary greatly, nor will the cost of the office force vary to any marked extent from month to month. With a small output the cost will naturally increase per 100 pounds, and, of course, the cost decreases as the output increases.

We will now consider the item of miscellaneous charges which includes repairs to tools, buildings, etc. In this column all expenses that cannot be included in other divisions must be charged. Repairs to tools include repairs to wood and iron flasks, sand mixers, molding machines, cars, trucks, ladles, tumbling mills, expense of the repair crew, as well as repairs to the buildings, benches, shelving, fences, runways, tracks, etc. In this division is also included other charges such as the cost of patching and filling defective castings, grinding chisels for cleaners, cost of making lifting plates, arbors, etc., and the daily freight and express charges on incoming materials. This item of miscellaneous charges should be watched closely as all repairs and replacals are absorbed in this sub-division. Many repairs can be made when the output of a foundry is large as the increased tonnage will hold this miscellaneous cost item to a reasonable figure. However, if the output is decreasing, such repairs which are possible with a large tonnage must be held over until the conditions are more favorable. The cost of pattern changes and repairs are entered in one column and it is also advisable to increase the amount of this work when the output is large as this will decrease the average cost of this work. The total cost per 100 pounds of good castings represents the cost of all labor and material required in the production of the month's output. The average cost per 100 pounds for one year is entered in the lower column of Fig. 5.

A curve sheet, compiled from the data entered on the report sheet, Fig. 5, is shown in Fig. 2. It will be noted that this sheet covers a period of 18 months, but can be extended to any length to cover a number of years. It will be noted that the average cost of iron and scrap, from January to August, 1900, greatly increased, but fluctuated during the succeeding five months. From the middle of December to the middle of March the cost of iron did not materially change, but a sharp decline was noted in April. The cost of molding was exceedingly variable, as indicated by the curve. This chart will prove exceedingly valuable to the manager of a plant as it shows at a glance the increases and decreases in the various items.

Fig. 6 is a record of miscellaneous data which will prove exceedingly valuable. A column is provided for the number of working days in each month, as well as the total number of working days in the year. A column is also provided for the total tonnage of iron melted. It will be noted that the average monthly total aggregates 31,117,000 pounds of iron melted. This should be considered 100 per cent. The output of good castings averaged 20,425,419 pounds per month, which was equivalent to 65.6 per cent of the total amount of iron

MISCELLANEOUS RECORDS

MONTH	YEAR	WORKING DAYS	TOTAL IRON MELTED	TOTAL IRON OUTPUT	PER CENT OF OUTPUT AGAINST IRON MELTED	AVERAGE WEIGHT OF CASTINGS MADE POUNDS	DAILY AVERAGE OUTPUT POUNDS	BAD CASTINGS POUNDS	PER CENT BAD
JAN.	1900	25	2,751,250	1,828,611	66 4/10	102	73,144	179,614	8 9/10
FEB.	"	22	2,608,870	1,732,700	66 4/10	127	66,642	186,321	9 7/10
MAR.	"	26	2,248,450	1,457,502	64 8/10	77	66,250	183,911	11 2/10
APR.	"	25	2,650,100	1,806,230	68 1/10	95	72,249	237,667	11 6/10
MAY	"	25	2,637,330	1,632,145	61 8/10	87	65,286	211,374	11 4/10
JUNE	"	24	2,983,210	1,551,241	51 8/10	98	64,276	186,978	10 7/10
JULY	"	27	2,738,160	1,869,490	67 8/10	96	69,240	161,103	7 8/10
AUG.	"	25	2,380,670	1,600,400	67 2/10	61	64,016	151,016	8 6/10
SEPT.	"	25	2,492,200	1,616,033	64 8/10	50	64,641	171,208	9 5/10
OCT.	"	26	2,853,160	1,866,904	65 4/10	45	71,804	161,214	7 8/10
NOV.	"	23	2,274,160	1,678,950	73 8/10	78	72,998	142,210	7 8/10
DEC.	"	24	2,499,440	1,785,213	71 4/10	102	74,384	177,487	9
YEARLY AVERAGE		297	31,117,000	20,425,419	65 6/10	83	—	2,150,103	9 5/10
MONTHLY AVERAGE		24 3/4	2,593,083	1,702,118	—	—	—	179,175	—
DAILY AVERAGE		—	104,771	—	—	—	68,772	7,239	—

FIG. 6—SHEET CONTAINING MISCELLANEOUS RECORDS OF FOUNDRY OPERATIONS

melted. The average monthly total of bad castings amounted to 2,150,103 pounds, or 9½ per cent of the total melted; thus, 75.1 per cent of the total iron melted is accounted for and the difference, amounting to 24.9 per cent, is not accounted for and represents melting losses, returned metal, gates, etc. It will also be noted that the average weight of the castings made is entered on this report and it will be found that this item will prove exceedingly valuable inasmuch as it has a considerable bearing on the output percentage as against the total amount of iron melted. These records can be varied to meet the requirements of any foundry, regardless of size.

PECULIAR PROPERTIES OF PIG IRON*

Considered with specific reference to chemical analyses and physical tests—Practical application of suggestions

By John Jermain Porter

IT IS perhaps not too much to say that the adoption of chemistry by the foundry has been responsible for a large part of the amazing advance of this industry during the past decade. Within this period, mixing by analysis has become the rule rather than the exception, and so much data has been published, and is now available along this line that further discussion seems superfluous.

There is, however, a related point in connection with the selection of pig iron for the mixture which has thus far received scant attention, but which is, in my opinion, worthy of most earnest consideration by foundrymen, and perhaps even more so by iron merchants and manufacturers. I refer to the great difference which exists in the behavior of many brands of pig iron and which apparently cannot be accounted for on the basis of chemical composition, as ordinarily determined.

In former days, now happily past, the old time founder, innocent of chemistry, swore by brands and possessed as part of his stock in trade a list of such, as had proved in his experience satisfactory and unsatisfactory. To the chemist this was ridiculous. From his standpoint, two irons having the same composition must have the same properties and give the same results, irrespective of brand name or anything else, and so earnestly has this doctrine been preached that his theory has won very general acceptance.

It is far from my intention to belittle the value of chemistry in the foundry or to deny the utility of analysis as a means of judging of the quality and fitness of an iron. Nevertheless I must take exception to the view still held by many chemists that analysis is *everything*, and maintain that there is something to be said for the arbitrary preferences of the older generation of founders. I believe it to be the case that there are many irons which have practically identical analyses and yet show marked differences in such important properties as strength and shrinkage, and I will now offer what evidence I have to support my views on this point.

Perhaps the most convincing evidence which has come to my notice is contained in a paper entitled "An Introduction to the Effect of Structure Upon the Physical Properties of Cast Iron", presented by F. J. Cook and G. Hailstone before the British Foundrymen's Association in 1909. In this paper it is recorded that of two mixtures practically identical in chemical composition the one was invariably much lower in tensile strength than the other, and this difference persisted through a great many heats and over a long period of time. The poorer mixture averaged about one-half of the strength of the better mixture, and in none of the 60 cases given is the strongest bar of the poor iron equal to the weakest bar of the good iron. The following analyses and tests are given as typical of the series, and in view of the exceedingly close agreement of these analyses it is evident that we must look elsewhere for the cause of the very great difference in strength:

	Series A	Series B
Tensile strength, tons per sq. in.	9.1	18.3
Total carbon, per cent	3.250	3.092
Graphitic carbon, per cent	2.397	2.289
Combined carbon, per cent	0.853	0.903
Silicon, per cent	1.328	1.314
Sulphur, per cent	0.095	0.101
Phosphorus, per cent	0.923	0.909
Manganese, per cent	0.290	0.335
Iron, by difference, per cent	94.114	94.149

A few years ago I was called into consultation by a certain foundry regarding a persistent case of trouble with shrink holes in small, chunky castings. It had been found by the foundry superintendent that the extent of the trouble apparently bore some relation to the mixture used, and hence experiments were carried out to determine what constituent or constituents were responsible for the difficulty. I am not at liberty to give full details of the results of these tests, but will present an outline of the experiments.

There were six brands of pig in the yard at the time, representing both northern and southern irons. Each of these irons was melted separately by using it alone in the first charge and separating the rest of the day's heat by a blank of coke. Working in this way, some 20 of the small castings, which had given the greatest trouble, were poured from each kind of iron. All conditions were kept as uniform as possible and the experiments were repeated several times with different lots of the various irons to minimize the danger of accidental interference of other factors. Finally, the castings were examined for shrinkage cavities with the following results:

Brand No. 1.—Castings all good, not a shrink hole in the lot.

Brand No. 2.—Fifty per cent perfect castings and 50 per cent with small trace of shrinkage.

Brand No. 3.—Ten per cent perfect castings and 90 per cent with small trace of shrinkage.

Brand No. 4—None perfect, all showed a little shrinkage.

Brand No. 5.—All castings with small shrinkage cavities.

Brand No. 6.—All castings very bad, with large shrink holes.

All of these irons were the ordinary No. 2 and No. 3 foundry grades, and while there were some variations in the analyses, there is absolutely no tracable connection between the percentage of any element or combination of elements and the results as to shrinkage. Moreover, the irons were each completely analyzed by a competent chemist and it was determined that the differences in behavior could not be attributed to the presence of

*Presented at the November meeting of the Pittsburgh Foundrymen's Association.

any unusual elements, or to unusual variations in the proportions of the carbons. Since these original experiments were carried out, others have been made on various mixtures of these brands, and it has been shown that the behavior of any mixture is approximately proportional to the behavior of its constituents, so that with equal parts of No. 1 and No. 6, most of the castings will show just a little shrinkage. It has also been found that the result from these irons affects the shrinkage in much the same way as the original pig.

It is quite well known among both foundrymen and blast furnace men that pig iron, made in whole or in part from mill cinder, is less desirable than that made entirely from ore, although the use of the mill cinder will not, as a rule, change materially the composition of the pig. The points of inferiority of cinder pig do not seem to be very clearly defined and have probably never been scientifically investigated. Nevertheless, they are real enough to affect its sales value, and in England are recognized by the creation of the grades of cinder pig as opposed to all mine pig. I have had some experience in the use of mill cinder in the blast furnace and have noticed that when using a considerable proportion of it, the iron was noticeably easier to break on the blocks, and there was invariably a decided increase in the unreduced iron in the slag.

Again, we have the case of charcoal iron, which in spite of the threats of foundry chemists to drive it from the field, is still produced in this country to the extent of some 400,000 tons per year, and is still regarded as indispensable for many classes of work. As far as analysis goes, there is but little average difference and no essential difference between charcoal and coke iron. Charcoal iron averages lower in sulphur, but any coke furnace can, and often does produce iron with the sulphur down under 0.01 per cent, which is as good as is expected from charcoal iron. Again, charcoal iron averages somewhat lower in total carbon than most coke irons, but here again the difference is not universal and if we should judge by analysis only, many coke irons could easily pass as the product of the charcoal furnace.

Coming to the properties of the two materials, however, it is within the experience of almost every foundryman that there is a difference. This is perhaps most generally noticed in the matter of toughness or strength, which in charcoal iron is much greater, the grains having a tenacity which causes the iron to tear to a marked degree rather than breaking off short. It is also noticed, however, in the properties of shrinkage, tensile strength and depth and character of chill, and since there is such a difference in properties and such a similarity in composition, I think it safe to say that we have here a notable example of that elusive difference which escapes the arts of the chemist.

Finally, I might cite the experiences and opinions of many competent foundrymen who have found the facts to be as I have stated. One authority in particular, Dr. R. Moldenke, has repeatedly called attention to these conditions.

The Manner of Cooling.

Although we may recognize the fact that differences in pig iron may exist, which cannot be accounted for by analysis, the explanation of these differences is another and a very difficult matter. It is true that, as in the case of steel, the methods of metallography furnish a clue, and under the microscope the structure of cast iron often shows remarkable variations. Cook, in the example first cited, found that his strong iron showed under the microscope a peculiar net work structure of the phosphide eutectic combined with much finer graphite than existed in the weak mixture. It is well known that charcoal iron is finer in grain than coke iron of similar composition and that this closer grain is an almost invariable accompaniment of strong iron. Hence, we may assume, that a part at least of the differences in pig iron is due to the variations in size, shape and arrangement of the graphite flakes. This is all right as far as it goes, but is only pushing the matter back one step and is not satisfactory as an ultimate explanation. In seeking the real explanation, five possible theories have suggested themselves, and these I will take up in order.

It has been known for many years that the rate of cooling is an important factor in determining the percentage of combined carbon, and lately it has become appreciated that it may also affect iron in other ways than through the combined carbon. For example, Custer, in his work with permanent molds, has shown that graphite size may be controlled without change in ultimate composition by varying the rate of cooling through the solidifying range, and others have found that hardness and electrical properties may be varied through quite wide limits by controlling the rate of cooling through a much lower range and without appreciably affecting the carbons. In my opinion, this possibility is due to a change in the allotropic state of the iron which takes place at about 1,400 degrees Fahr., and which is not made evident by chemical analysis.

However, though granting that the manner of cooling may produce many important changes, I still cannot believe that this theory is competent to account for the examples previously given. In the case of both Cook's experiments and those coming within my own experience, rate and manner of cooling were as nearly similar as it was possible to make them, and the number of pieces tested was too great to permit of the possibility of a coincidence of accidental variations in this factor. Moreover, the persistences of the differences after the remelting of the irons cannot be explained on this basis.

Another theory which may possibly be thought by some to afford an explanation is the manner in which the elements of the pig iron are combined. There are six elements present in cast iron and some 12 or 15 constituents are possible through the different forms of combination of these elements. There is, however, nothing to indicate that there is anything in this theory, and even if we could account for it on this basis, there would still be the question why two brands of the same elementary composition should have their elements combined in such different ways as to produce different properties.

Recently, considerable attention has been given to the gaseous impurities of steel and it has been found that nitrogen is a rather common and a very detrimental impurity. May it not be the case that the presence of more or less of this element, which is not determined in the ordinary analysis, explains the differences which I have described? This appears a more likely explanation than any of those thus far cited. I do not, however, regard it as the right one, or at least the chief one. There is very little evidence either for or against it, but such as there is appears to be against it. The well known experiments of Braune seem to indicate that nitrogen is seldom or never an important factor in gray cast iron, although it may be sometimes in white or chilled iron; and Gayley has

described some tests made on the nitrogen content of different classes of pig iron in which he found that there was apparently no relation whatever between the amount of nitrogen and the quality.

Perhaps the most generally accepted theory to account for otherwise unexplainable differences in cast iron is to assume the presence of variable amounts of oxygen in the metal. This theory is due more especially to Dr. Moldenke, who, in several papers, has cited considerable evidence in its support. Perhaps the most conclusive evidence is the actual isolation of magnetic oxide from samples of iron which have been badly burnt on the hearth of an air furnace and which are known to have had the characteristics commonly attributed to oxidized metal. This theory fits in well with all that is known regarding the relation between blast furnace practice and the properties of the iron made. For example, mill cinder is a particularly difficult material to reduce and it has a well marked detrimental effect on the quality of the pig iron produced. Still another example mentioned by Dr. Moldenke is the difference in quality between malleable Bessemer, made in a lightly blown furnace, and regular Bessemer, made in a furnace driven to the limit.

While accepting this last theory as probably substantially correct, I would suggest that possibly a modification of it may be still nearer the truth. It is generally assumed that the oxygen is present as dissolved oxide of iron, but it seems to me possible, if not probable, that it may be rather in the form of an oxy-sulphide of iron. This compound has been shown by Campbell to be capable of existing in iron and steel at high temperatures and to have remarkable powers of diffusing through the solid metal. Le Chatelier has also proven its existence.

The evidence as to its presence and influence in commercial iron and steel is only indirect but there is some circumstantial evidence pointing in that direction. It is quite noticeable in blast furnace practice that following a slip bringing unreduced ore into the hearth, there is a most evident association of badly oxidized iron and very high sulphur. It is also well known that it is particularly difficult to keep the sulphur down when smelting mill cinder.

In a paper by Herbert Pilkington, read before the British Foundrymen's Association in 1911, it is stated that many of the best cold blast charcoal irons contain 0.10 per cent sulphur and upwards, and that this quantity, which would be ruinous to ordinary pig, does not in this case produce unsoundness or other bad effects. Finally, I know of several observant foundrymen, who are quite certain that sulphur is sometimes much more injurious than at others, and this fact, if such it be, may or may not be caused by its association with variable amounts of oxygen in the form of oxy-sulphide.

Furnace Practice and Iron Quality.

Thus far my discussion has been largely academic and a more practical question is the relation between blast furnace practice and the presence in the pig iron of these injurious properties, however they may be caused. Unfortunately, we have not enough data to draw exact conclusions, or indeed, any conclusions. My observations have led me to accept as a tentative theory the rule that the less oxidizing the conditions under which the iron is made, the better will be its quality. In other words, satisfactory iron should be made from easily reducible ores, with a moderate rate of driving and with not too much economy of fuel. These conditions, if correct, are rather hard on the furnace man and it is to be hoped that further information may modify them somewhat. It is a significant fact, however, that in a large number of cases the irons having the highest reputation for low shrinkage and general good casting properties, are made in small furnaces inadequately provided with blowing capacity and hence, lightly driven, and using brown hematite or other easily reducible ore.

I have thus far been unable to determine whether those factors in the operation of the furnace, which are within the control of the furnace manager, have any important effect upon these properties of pig iron, but it is probable that, to some extent, they have. It is a well known fact that the grain of the pigs may be varied within wide limits without regard to composition by varying the basicity of the slag and the temperature of the hearth. It is also well known, however, that upon remelting the character of the grain is changed and becomes normal and so far as I know, it has never been definitely shown that the size of the grain in the original pig bears any relation to the properties of the iron after remelting, at least none which cannot be explained on the basis of composition.

On the other hand, I have noticed certain indications which lead me to believe that it is possible to accomplish something by the way the furnace is handled. For example, it appears that the bad effects of mill cinder may be at least partially nullified by slow driving and the use of some excess of fuel. Again, magnetic ore appears to make a satisfactory foundry iron, although it is very hard to reduce, but furnaces using it are generally driven rather slowly. Reasoning entirely from theory it seems likely that the presence of ferrous silicate in the ore, the formation temperature of the slag (not the melting point), the temperature of the hearth and the freedom from slips may all have something to do with the quality of the iron. It would be interesting to follow up some of these points; for example, to compare the iron made by the use of dry blast with that made under otherwise similar conditions, but using moist blast. Dry blast greatly increases the hearth temperature, thus producing conditions identically opposite those under which cold blast charcoal iron is made; yet it is quite possible that it may produce an effect of the same kind on the pig, although less in degree.

The practical application of the facts which I have here tried to bring out may not seem to be of any great importance, but I am not so sure that this is the case. Sometime ago I had a talk with a foundry superintendent of wide experience, and in discussing the experiments on fluid shrinkage, previously described, he insisted that to many foundries this property is one of the most important and difficult problems, and is responsible for a much larger number of defects than is generally supposed. According to this foundryman, the question of the influence of brands upon this property is well worth the study of the practical foundryman. There are, of course, many foundries where neither fluid shrinkage nor high strength are of any particlar importance, but on the other hand, there are some classes of work where one or both of these properties is of very great importance, and in such cases it appears to me that a knowledge of brand characteristics is almost indispensable.

As there is no published and very little privately held information along these lines, it is necessary for each founder to gather his own data, and

the procedure which I recommend is as follows:

First.—A fluid shrinkage and transverse strength test from each heat.

Second.—A continuous record of the results of these tests and the mixtures used.

Third.—Occasional tests of the different brands melted separately.

In regard to the test for fluid shrinkage, I have found that originally recommended by Cook and consisting of a casting in the shape of a K, with the legs about 1 inch square in section, to be very satisfactory. When this casting is broken at the junction of the legs, any tendency towards fluid shrinkage will be evident there. In using this test, it is convenient to construct a scale consisting of a series of from four to eight broken K castings of varying degrees of badness. These are mounted in a box and given suitable numbers. Thereafter it is sufficient to compare any test piece with this scale and to record its shrinkage, by the number on the scale most nearly resembling it.

It will be evident that the obtaining of this data need not be at all burdensome to the foundry undertaking it, since no special apparatus is called for, except a transverse testing machine, and the extra work involved will hardly amount to 20 minutes per day of a helper's time. Even the special tests of separate brands need not interfere with ordinary foundry routine, since they can be run as the first charge in a regular heat.

Another conclusion which might be drawn from the facts brought out is that there is a great opportunity for some of the manufacturers and sellers of foundry pig iron to make strong selling points of these special virtues, once they have found them in their brands. I am quite convinced that the larger commission firms would find it very much to their advantage to have the properties of the brands they handle thoroughly tested so that they could sell them more intelligently.

Finally, it appears to me that the recognition of the injurious effects of the gaseous impurities in cast iron will give a fresh argument to the electric furnace man. I have long thought that it should be practicable to use an electrically-heated receiving ladle or mixer in connection with either a blast furnace or cupola. Here the iron could be partially refined, treated with de-oxidizing alloys, adjusted in composition and brought to any desired casting temperature; and since there would be no melting to do, the amount of electrical energy needed would be relatively small. Operated on a sufficiently large scale to take care of the fixed charges, it appears to me that this combination could be made profitable for some lines of work.

Casting Brass Oil Cups on Steel Straps

By Louis Luhrsen.

Considerable difficulty is experienced in lubricating locomotive connecting rod brasses. The oil cups on the straps are frequently jarred loose and several ways of securing them have been tried

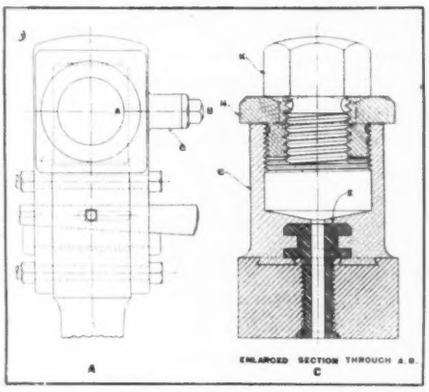


FIG. 1—VIEW OF A LOCOMOTIVE MAIN ROD STRAP, SHOWING THE OIL CUP AND A CROSS-SECTION OF THE LATTER WHEN CAST ONTO THE STRAP

such as bolting and screwing them to the strap. This, however, has proved unsatisfactory. An effort was also made to weld cast iron oil cups onto the strap, but this method also did not overcome the difficulty as the strap was warped by the heat to such an extent

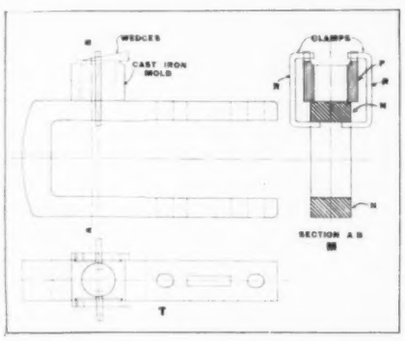


FIG. 2—SIDE VIEW, PLAN AND SECTIONAL ELEVATION OF THE STRAP, SHOWING THE IRON MOLD

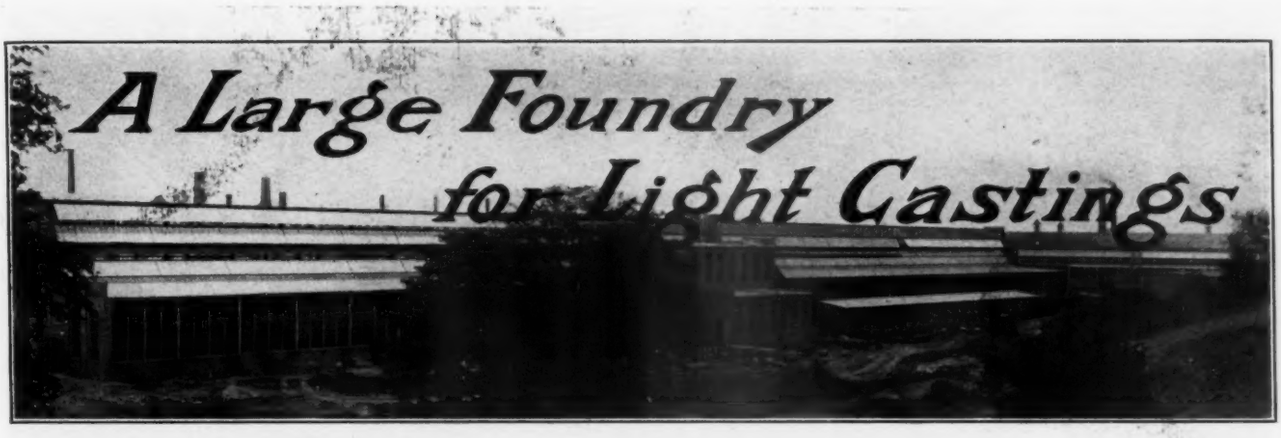
that it could not easily be straightened again.

After considerable difficulty it was decided to cast the oil cup onto the strap. A view of the main rod strap with the cup in position is shown at *A*, Fig. 1, and *C* is a sectional view of the strap through the oil cup, showing the method of anchoring the cup to the strap by the bolt, *E*. The oil cup is shown at *G*, while *H* is the brass cap and *K*, the plug.

As shown in Fig. 2, an iron mold is used for casting the brass oil cup. In this illustration *M* is a section through the clamp and the mold, *N* being the strap, *P* the iron mold and *R* the clamps. At *T*, Fig. 2, is shown a side view and plan of the strap with the iron mold in position. The success of this casting operation depends upon the proper preparation of the bolt head and the dovetailed groove in the strap. Ordinary brass is used and the cups, when cast in this way, never work loose. The metal thickness of the brass cup after it is turned and bored is ¼ inch.

Renovating Molding Sand

A process for treating molding sand so that it can be used over again has been recently patented in Great Britain. It consists of treating the sand with a solution of sulphate of alumina and water, alone or in combination with gelatinous silica. The sand may also be treated with alumino-ferric cake, with or without the addition of silicate of soda. The sulphate of alumina may be added to the sand in several ways; it may be powdered and the powder mixed with the sand, water being added as required, or the sulphate may be ground and mixed to a paste with water, or it may be dissolved in hot water without being ground. The inventor, however, prefers to add the sulphate in the form of a solution, made in the proportion of one pound of sulphate of alumina to 12 pounds of water, and uses 160 pounds of this solution to the ton of sand, while for cores and dry sand work, more of the sulphate of alumina solution is desirable. A stronger sand is made when the sulphate of alumina solution is used in conjunction with gelatinous silica, in which case equal parts of the sulphate solution and gelatinous silica are mixed together to form a mixture which may be added to the sand in any proportion up to 160 pounds per ton of sand. For cores and dry sand molding the simple solution of sulphate is considered the best, but in the renovation of green sand, the mixture of sulphate and silica is considered the best. The gelatinous silica specified in the patent is silicate of soda or water glass, that is so extensively used as a binder for furnace linings.



A Large Foundry for Light Castings

Details of Construction and Arrangement

IN THE manufacture of its varied line of products, the International Harvester Co., Chicago, requires a large tonnage of castings, and a foundry is one of the important departments of practically each of its plants. Two large gray iron casting shops have been erected during the year by the Harvester company, located, respectively, at Milwaukee and Springfield, O. The Milwaukee foundry was described in THE FOUNDRY, May, 1911, page 98. One of the features of this shop is the gallery for light castings, which increases the molding floor area practically 50 per cent. The limitations of the site on which this plant was erected made it necessary to erect this gallery floor. In addition, the roof of this shop is of the saw-tooth type.

The new plant at Springfield covers sufficient ground to permit of concentrating all of the molding operations on one floor. The main foundry building is 676 feet long and 150 feet wide. One end of the shop, 150 feet square, has been partitioned off for the casting cleaning department. The auxiliary buildings, in which are located the core department, molding and core sand storage, coke storage, pattern vault, toilet rooms, cupola house and scrap bins are arranged on either side of the main structure, as shown in Fig. 14. Some of these buildings are entirely detached from the main structure, although a number are in the form of lean-tos to the foundry.

The foundry building is of steel construction with brick curtain walls and the sides and ends contain numerous rows of windows, thereby insuring ample light. While the original plans provided for a saw-tooth roof, the specifications were changed before the building was erected at the suggestion of W. D. Price, superintendent of construction for the Harvester company, and a modified form of the Pond type of monitor roof construction adopted. A cross-section of the building, showing the roof construc-

FIG. 1—VIEW OF THE MAIN BAY OF THE INTERNATIONAL HARVESTER CO.'S NEW SPRINGFIELD, O., FOUNDRY

FIG. 2—VIEW OF THE FOUNDRY FROM THE MILL ROOM

tion, is illustrated in Fig. 13, and it will be noted that the roof is a radical departure from the V-shaped monitor type. As usually built, the peak of the monitor is the highest portion of the building and the ridge follows the center line of the structure. It is customary to install a row of windows in the sides of the monitor, but the illumination is considerably curtailed by the shadows of the eaves of the monitor roof and the ventilating capaciy of the monitor is reduced as the gases may be entrapped along the ridge which extends considerably above the openings in the sides of the monitor. Unless ventilators are installed in the roof of the monitor, the entrapped gases may again descend to the lower level in the shop.

Roof Construction.

In the type of roof construction adopted, the sides of the monitor form the high points of the building and the roof is in the form of an inverted gable with the ridge at the lowest point, as illustrated in Fig. 13. The sides of the monitor are equipped with continuous steel sash fitted with ribbed glass extending from the roof of the bay to the highest point of the building. Four tiers of skylights, *C*, *D*, *F* and *G*, Fig. 13, extend from the roof of the lowest to the highest part of the building. The two lower rows of windows are set at an angle and the bottom row is 5 feet, 10½ inches high, while the upper row is 4 feet 10½ inches high. In the monitor the glass is set vertically, both tiers being 5 feet, 10½ inches high and the total height of lighting surface in the roof is 22 feet, 6 inches on either side of the building. As shown in the general view of the plant, Fig. 12, the sash is continuous and extends the entire length of the structure. This roof construction provides maximum lighting efficiency and, in addition, affords an abundance of ventilation. The building was designed and its construction was supervised by the De Vore & McGormley Co., engineers, Nasby building, Toledo.

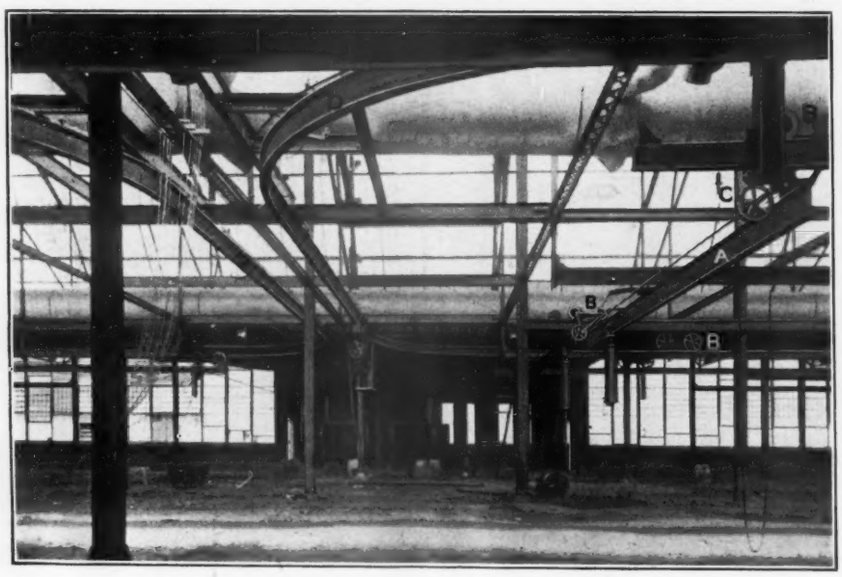


FIG. 3—VIEW ACROSS THE CENTER OF THE SHOP SHOWING THE CUPOLAS, THE TWO MONO-RAIL TRACKS AND THE TRAVELING AIR HOISTS

Shop Lighting.

The extreme height of the main building is 48 feet and the side bays are 23 feet, 9 inches high and 32 feet wide. The width of the main bay is 86 feet. The windows in the sides of the building are carried up to the eaves of the side bays and the sliding sash is in three sections which permits of opening the top and bottom of each window at the same time. The width of the monitor is 66 feet, 10½ inches and the V-shaped roof is of cement construction, which is

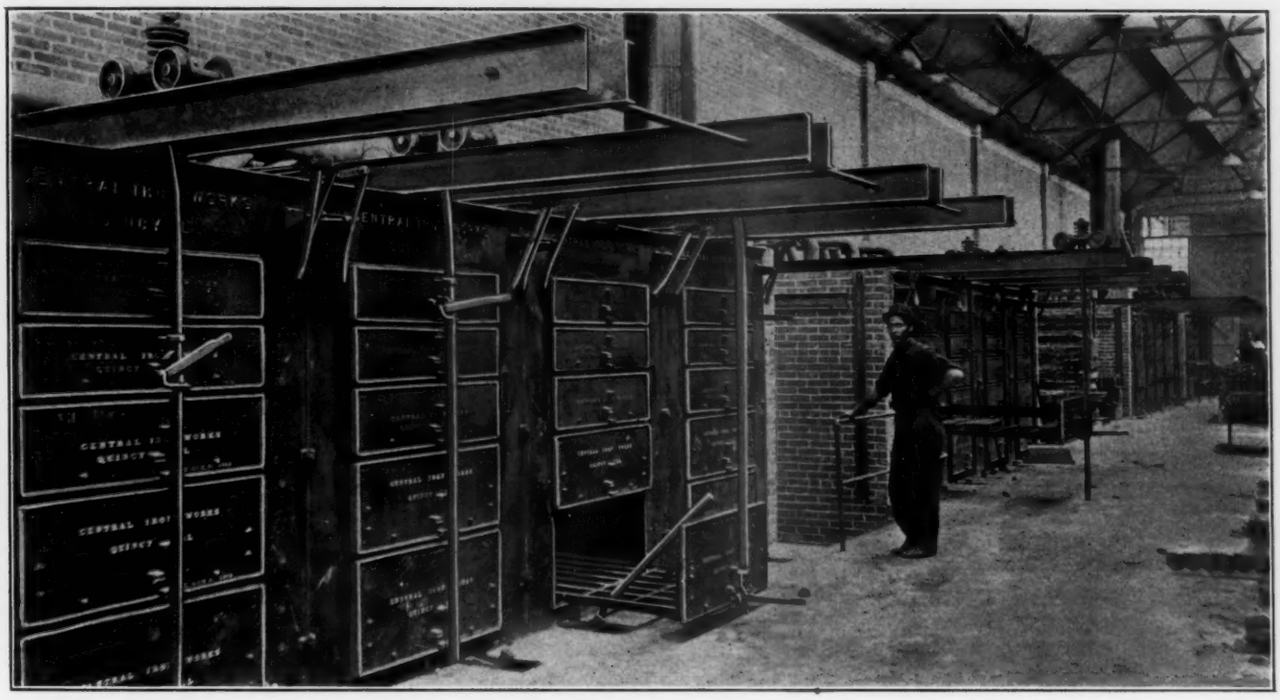


FIG. 4—THE CORE DEPARTMENT, SHOWING THE FOUR BATTERIES OF OVENS

applied to a skeleton of perforated metal. The cement is covered on the outside with layers of felt, tar and gravel which make the roof absolutely waterproof. The roof over the side bays is similarly built. The monitor slopes toward the center, forming a gutter which extends the entire length of the building.

In designing this structure, the architects adopted a light form of steel construction which possesses several novel features, particularly in the design of the roof trusses, *H*, Fig. 13. This construction effected a saving of 50 per cent in the amount of steel required. The general view of the foundry, Fig. 1, shows how well the light is diffused toward the center of the building. The hot air main will also be noted, which extends through the middle bay with numerous branches to the side floors. The office of the general foreman is shown at *A*, and *B* is the entrance to the core room. The middle bay is devoted almost entirely to floor work, while in the side bays all of the bench molding is done. Gray iron castings are exclusively manufactured and approximately 45 per cent of the molds are made on molding machines.

Owing to the light nature of the work produced, overhead traveling cranes are not required and the metal is delivered to the various molding floors and molds are rolled over by mono-rail electric and air hoists which command every portion of the molding floors. The air hoists operate on overhead I-beams, which reach every section of the shop. Fig. 3 shows a section of this mono-rail system, as well as the traveling I-beam, *A*, which is supported at either end by two large wheels, *B*, Fig. 3, and which operate on tracks, *A*, Fig. 13. These tracks are suspended from the roof trusses. As the air hoists are supported by the traveling I-beams, they can be moved across that part of the floor commanded by the beam from which they depend while the beam has a longitudinal travel through the particular section of the shop which it is designed to serve. The traveling I-beam crane with its hoist is controlled from either end by means of hand chains which pass over the pulley, *C*, Fig. 3. In addition to this air hoist system, which serves the molding floors, there are two mono-rails, each equipped with an electric hoist and car, installed by

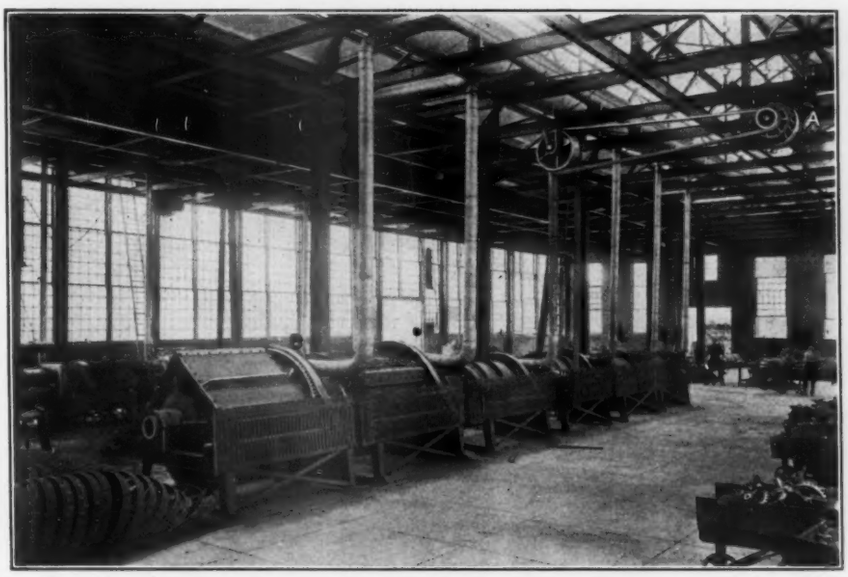


FIG. 5—A CORNER OF THE CLEANING ROOM, SHOWING THE METHOD OF SAFEGUARDING THE TUMBLING BARRELS WITH FENCES AND ENCLOSED GEARS

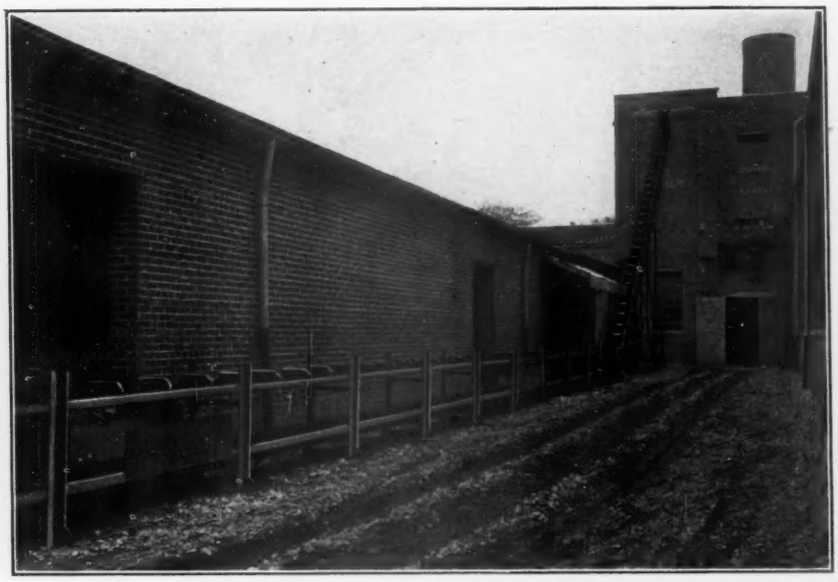


FIG. 6—THE COKE STORAGE AND COKE CONVEYOR WITH THE CUPOLA HOUSE IN THE DISTANCE

the Pawling & Harnischfeger Co., Milwaukee. The mono-rails extend through the side bays, as shown at *D*, Fig. 1, to a point opposite the cupolas, where they turn at right angles across the shop and run parallel to the cupolas, where they again diverge. One mono-rail passes the door to the pig iron storage yard and at a point directly over the center of the industrial railway, to which it delivers gates and scrap intended for either yard storage or the cupola. A view of this mono-rail layout, which shows the parallel track to the cupolas, is illustrated in Fig. 3. In this shop the molds are shaken out at night and the castings are loaded onto buggies which are conveyed to the mill room by the mono-rail hoist. A view of this hoist, with one of the buggies on the floor, is shown in Fig. 8.

The cleaning room is 150 feet square and is equipped with an adequate number of tumbling barrels, emery wheels and chipping benches. The tumbling mills are served by an exhaust system which carries away the dust and the separator is located between the fan and the mills and exhausts the air back into the room. The separator is located directly underneath the monitor of the cleaning mill building and is sustained by the girders over the center of the shop. The exhaust spouts from the separator are illustrated at *A*, Fig. 8. The tumbling barrels and emery wheels are arranged for group drive from motor-driven countershafts. The motor for the tumbling barrels is shown at *A*, Fig. 5. The safeguards on the tumbling mills are unique and it will be noted that the back of each mill is protected by a steel guard resembling a fence, while the large gears driving the mills are guarded as shown at *B*, Fig. 5. All of the emery wheels are practically enclosed with steel hoods. Directly above the charging side of the tumbling mills is an I-beam trolley, on which is operated an air hoist which facilitates the charging and discharging of the mills.

The tumbling barrels, emery wheels and chipping benches are arranged in parallel and the gangways between them are in line with those of the foundry. Access to the gangway in the foundry can be had through the cleaning department without being compelled to pass obstructions that might lead to accidents. A view of the foundry from the mill room end is shown in Fig. 2. In the foreground, chill molds for casting hubs around the spokes of wheels for agricultural implements, are illustrated. This work, however, is only carried on temporarily in the new foundry and will later be transferred to the other shop which is now being equipped for this purpose.

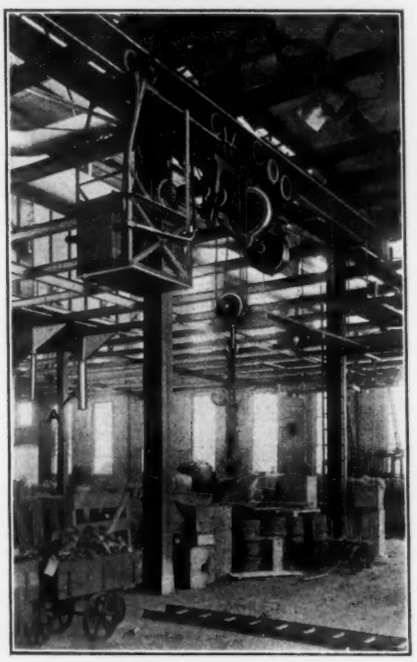


FIG. 8—THE MONO-RAIL HOIST AND CAR

FIG. 7—A VIEW IN THE CORE ROOM

An interesting feature of the shop practice is the arrangement of the

sand piles which extend the length of the shop and not across the width, which is almost the universal practice. There are four piles of sand and when the castings are removed the sand is tempered and cut-over by a sand mixer, which prepares four continuous piles of sand in readiness for the molders. The sand mixer was installed by the Auto Sand Mixer Co., New York City.

Melting Equipment.

The melting equipment consists of two 78-inch cupolas, installed by the Whiting Foundry Equipment Co., Harvey, Ill. These furnaces have a capacity of about 25 tons per hour and are used alternately. The cupolas are located in a melting house of brick and steel construction, which is situated about the center of one side of the main building. The charging platform, Fig. 9, is covered by a steel plate floor which facilitates the movement of the charging buggies. A section of the coke hopper, *A*, is shown in Fig. 9. The charging floor is served by a 5-ton elevator. Located on one side of the melting house is the coke storage building and on the opposite side are the pig iron storage yard and the concrete scrap bins. An industrial railway system serves the entire iron storage yard, as illustrated in Fig. 10. The charges are here made up, weighed and loaded into cars for delivery to the charging floor. All of the iron as it is received in cars is carefully stacked in piles, according to analysis, grade and brand and between the piles narrow gage tracks extend from turntables to facilitate the loading of the material into the charging cars. When loaded, the cars are pushed onto the main track and are delivered to the elevator in the melting house, passing, in transit, over a track scale.

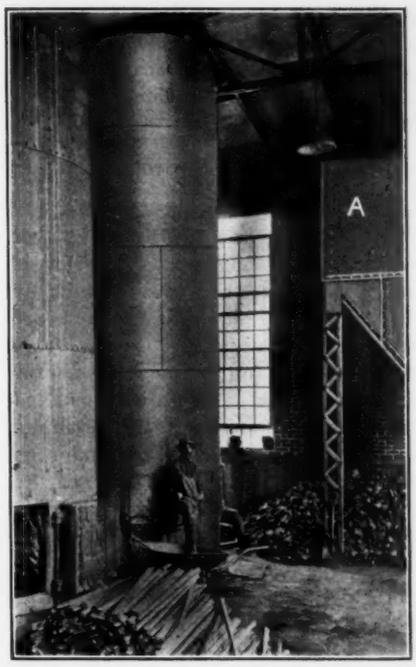


FIG. 9—THE CUPOLA CHARGING FLOOR, SHOWING THE HOPPER INTO WHICH THE COKE CONVEYOR DISCHARGES

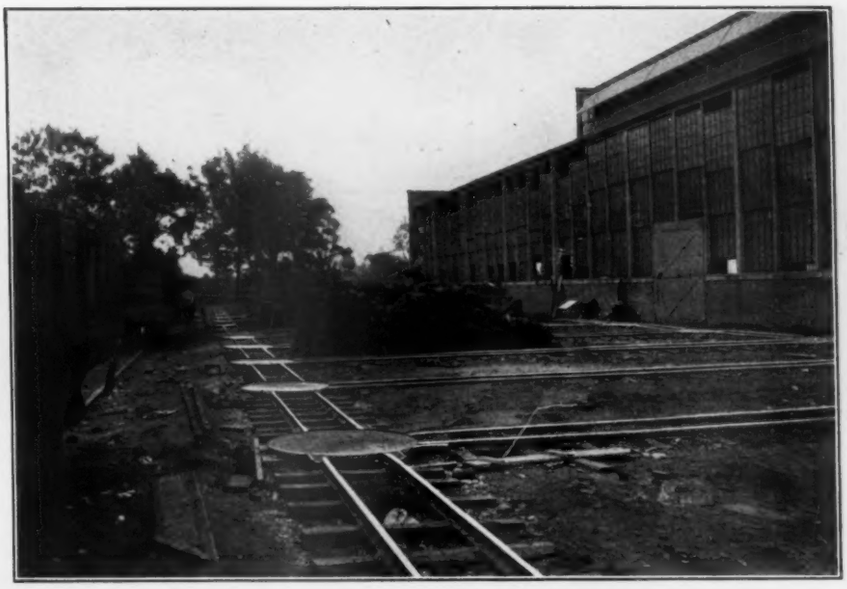


FIG. 10—THE PIG IRON STORAGE YARD, SHOWING THE NARROW GAGE RAILWAY SYSTEM

Coke Conveyor.

The coke is conveyed from the coke storage building to the charging floor by an exceedingly interesting conveyor system, Fig. 6, installed by the Chain Belt Co., Milwaukee. This conveyor extends the entire length of the coke storage building and discharges into the hopper on the charging floor shown at *A*, Fig. 9. The coke is discharged from chutes in the coke storage onto the conveyor, which is motor-driven. The blower house is a one-story lean-to to the cupola house. The blast is furnished by a blower installed by the Piqua Blower Co., Piqua, O., which is driven by a variable speed motor which permits the blast to be adjusted to the melting requirements. In the blower room is also installed a motor generator set which furnishes the current for the electric hoist. This set consists of an alternating current motor and a direct-current generator. All of the electric equipment is carefully safeguarded and the wiring throughout the build-

FIG. 11—A VIEW IN THE LAVATORY, SHOWING THE PORCELAIN WASH BOWLS

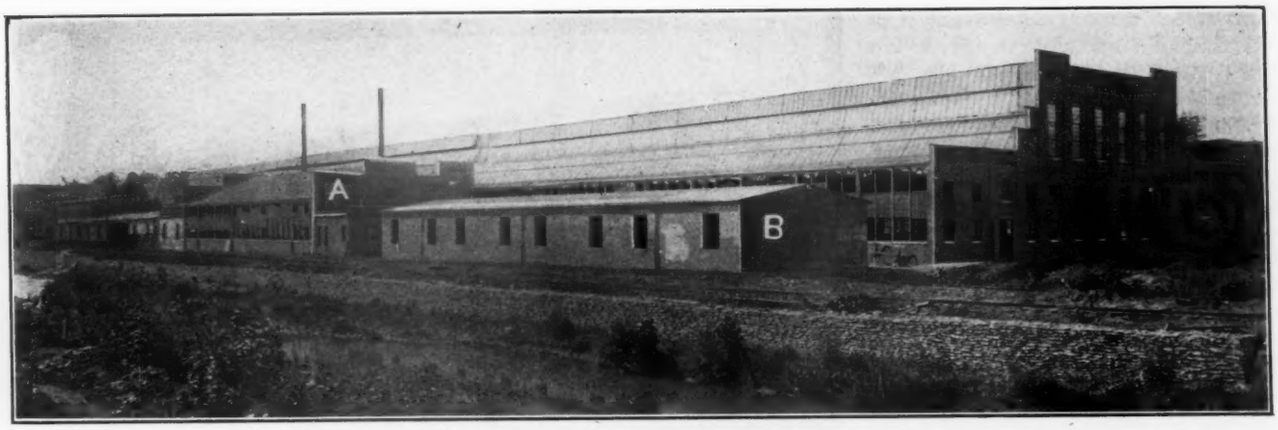


FIG. 12—VIEW OF THE FOUNDRY BUILDING FROM THE SOUTH, SHOWING THE CORE DEPARTMENT AND SAND STORAGE

ing is carried in conduits. A cinder mill is provided for the recovery of iron. Throughout the entire shop sanitary drinking fountains have been installed.

Core Shop.

The core shop, which is 145 feet long and 55 feet wide, adjoins the main foundry building. A brick wall extends longitudinally through the center of this building, which divides the core ovens from the coremaking department. A view of the core ovens is shown in Fig. 4. This equipment consists of four batteries of four ovens each. The ovens are of the roller drawer type, and are equipped with thermometers for making temperature measurements. It has been found that the temperature limits range from 225 degrees Fahr. as the minimum, to 275 degrees Fahr., maximum. A fairly good average to maintain is about 250 degrees Fahr. Each oven door is equipped with an indicator for timing the stay of the cores in the ovens. This indicator consists of a cast iron clock dial with raised figures and a movable hand in the center. When the cores are placed in the oven the hand is set to indicate the time when the cores should be removed.

The coremaking department is illustrated in Fig. 7. The benches are arranged along the wall. A girls' rest room has been provided, which is located in the building shown at *A*, Fig. 12, which is in the nature of a lean-to of the core shop. The core sand storage is illustrated at *B*, Fig. 12. This is a concrete structure with a cement roof. The reserve supply of molding sand is carried in two concrete buildings situated on either side of the core department. These sand storage buildings have numerous openings which are on a level with the floors of the freight cars received over the spur track paralleling this department. The wash rooms for the men are located in a two-story building and a view of a row of the porcelain a view of a row of the porcelain wash bowls is shown in Fig. 11. On account of the large number of negroes employed, separate wash rooms have been provided for their use.

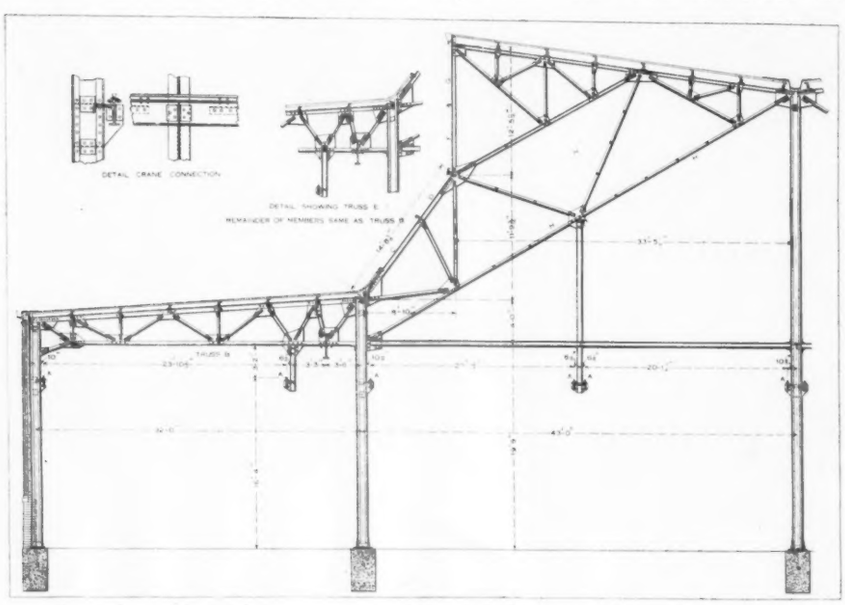


FIG. 13—A CROSS-SECTION OF THE FOUNDRY BUILDING SHOWING THE ROOF CONSTRUCTION

Heating System.

An elaborate heating system has been installed, the overhead, hot air system being employed. The air is heated by cast iron heaters, built by the American Radiator Co., which are heated by the exhaust steam from the power plant. The blower for this ventilating system was installed by the Buffalo Forge Co., Buffalo. One of the large hot air mains is shown in Fig. 15. This delivers the heated air to the mains on either side of the shop from which branch pipes lead to the side bays.

The pattern storage building is of brick construction and is located at some distance from the foundry. This building has only one opening and all precautions have been taken to make it absolutely fireproof. Artificial illumination is afforded by tungsten and flaming arc lamps; the tungstens are located in the side bays, while the flaming arc lights extend through the middle bay.

To safeguard the foundry workers against foot burns and other accidents, all of the employes of the casting department are required to wear congress shoes, which are furnished at a low cost by the company.

The firm of T. P. Kelly & Co., New York City, manufacturers of foundry supplies and equipment, will be continued under its present name. The firm is now composed of M. F. Kirby, P. A. Kirby and W. F. Kaine Jr.

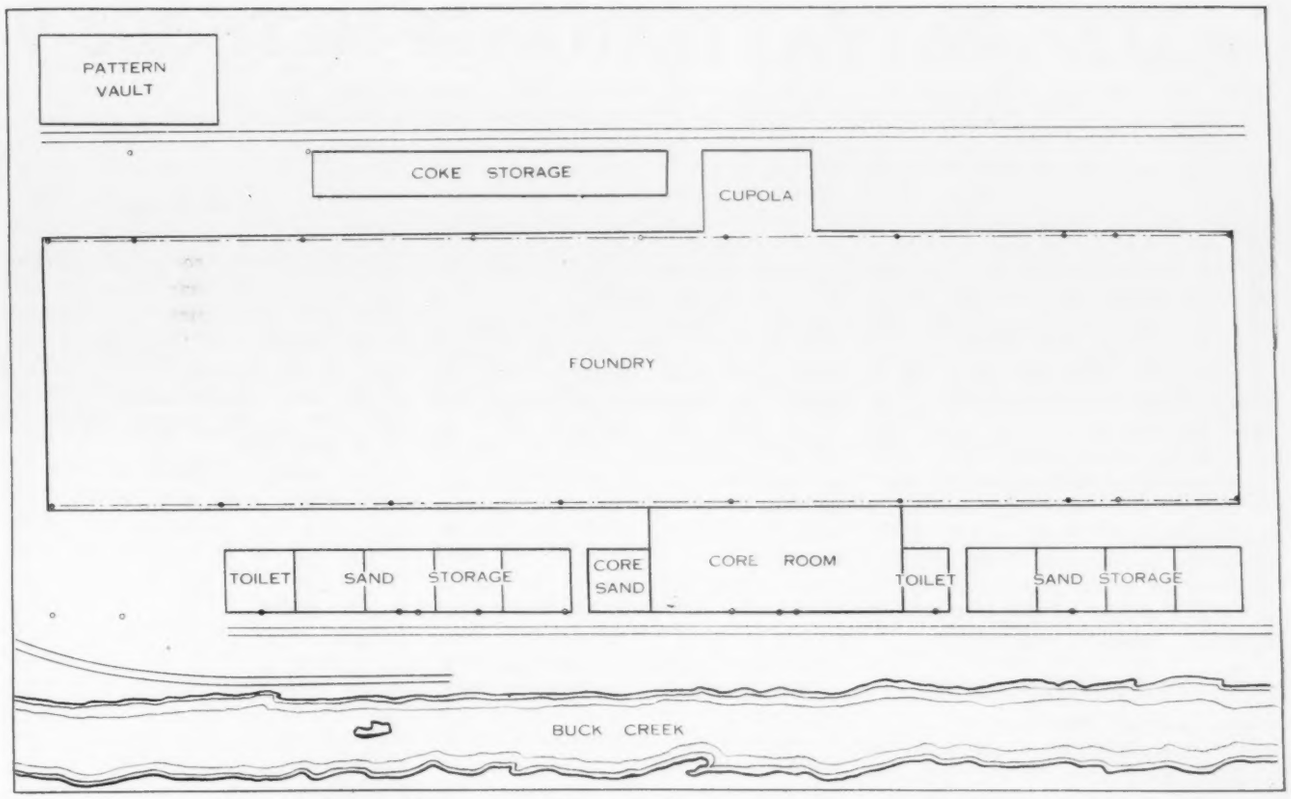


FIG. 14—GROUND PLAN OF THE FOUNDRY, SHOWING THE LAYOUT OF THE BUILDINGS

Cleaning Castings for Plating

By N. W. Shed

Question:—Is there any particular iron mixture especially adapted for castings that are to be copper-plated?

Answer:—There is no special mixture adapted for iron castings that are to be plated. It would be advisable to obtain a metal low in graphite and silicon. The principal difficulty in securing a good surface is the presence of sand spots. These can be removed by thorough pickling in hydrofluoric acid. There may be some scale on the castings, but this can be removed by hot muriatic acid. The main object is to obtain a thoroughly clean surface before coating with copper. The directions given by W. T. Flanders in "Galvanizing and Tinning" should be followed to obtain clean castings for plating.

A strong and valuable alloy for all purposes where a high grade metal is required is made as follows: Melt 75 pounds of copper and add 25 pounds of zinc. The copper should be melted under a flux composed of the contents of two old dry batteries which have black oxide of manganese as one of their component parts. The yellow brass so produced is run into ingots, and is used for making gun metal by melting 20 pounds with 72 pounds of copper. The copper is first charged into the furnace with a handful of salt and some charcoal, and when the metal becomes red hot, the ingot brass is charged. The metals are then melted together, and after the molten mass has been well stirred, eight pounds of tin are introduced with further stirring. The metal is then raised to the proper casting temperature, its surface being covered with a thick layer of charcoal.

FIG. 15—LARGE HOT AIR MAINS, BY WHICH THE AIR IS DISTRIBUTED TO THE THE VARIOUS BRANCHES THROUGHOUT THE SHOPS

LATTER-DAY PATTERN SHOP METHODS-V*

The construction of patterns for feed water heaters, steam and oil separators, and cast iron car wheels

By W. S. Giele

THE manufacture of open-feed water heaters involves essentially the construction of cast iron boxes of various sizes, with openings for pipe connections and doors which permit access to the interior. The wide variation in operating conditions in different steam plants, both as to the size and the character of the piping and the number of sources of supply for steam and water, as well as the provisions for drawing steam and water from the heater, make it necessary to provide many special features on otherwise standard construction.

Molding Feed Water Heaters.

The smallest sizes are cast in a single piece, with the exception of the top. These are cast on their side by the Harrison Safety Boiler Works, Philadelphia, the parting being on one of the outside faces of the box. The bottom is pitched for drainage and is provided with lugs to which the pipe legs are attached. The bottom, with its attached legs, is made loose on the pattern and all the pieces for the openings are also loose. The screws which hold these loose pieces to the pattern are taken out as the ramming progresses and when the ramming is finished, the main pattern is withdrawn and the bottom and bosses are drawn back into the mold. This construction makes it easy to transfer the bosses to one side or the other, on the pattern, thus making it possible to mold right and left hand heaters from the same pattern. The interior of the casting is formed by a dry sand core rammed in a box, the projections on the inside of the casting for supporting the interior parts of the heater being made loose in the box and are drawn out of the core after the box has been removed. The core is supported by a print projecting from the top opening of the box and also by prints extending through the door openings in the sides of the heater. The heater is cast in such a position that these door openings are on the bottom, thus carrying the weight of the core.

The flask is cut away at the end to facilitate the removal of the interior of the core, which is filled with coke so that the core will crush before the casting cracks.

Large sizes of heaters are built up of separate plate patterns. These plates are made of wood and are molded by ramming them on a board. These large plate patterns must be strengthened by ribs and the various bosses required are attached to the pattern where needed, each boss usually carrying its own core print, the openings being made with dry sand cores. The bosses are cut over rather than through the ribs. If these bosses and openings are of standard sizes, this method affords a good illustration of the relative economy of making openings in this way, even though it might be entirely possible to mold them in green sand.

The attachment of separators for removing the oil from the exhaust steam which goes to the heater, involves the casting of a considerable number of bolting flanges which must be raised from the surface of the plate to allow clearance for the nuts between the flange and the plate. This undercut is handled with dry sand cores rather than making the flanges loose and drawing them back in the mold, as a pattern made in this way would be weak and there would always be a tendeny for the loose flanges to become displaced during the progress of the ramming, thus resulting in castings which cannot be machined to the proper shape.

Steam and Oil Separators.

The making of castings for steam and oil separators involves a large amount of difficult core work and the core boxes are more interesting than the patterns. Separator heads resemble pipe tees with an enlarged body and are always made with flange connections. One of the most difficult problems is the baffle in the interior of the head, which cuts the core in two, except at the steam ports. Wherever possible these cores are made in boxes with the baffle loose on the top or on the open side of the box. These cores must be supported by crabs, and as it would be impossible to get the crabs out of the castings after they are made without breaking them, these crabs are cast in open sand.

Separator cores are frequently made in halves which are bolted together, thus securely holding them to each other and preventing any variation in the thickness of the baffle or sidewall of the casting by the shifting of the core. A bolt extends through the baffle in the casting and is cut off at each side.

The flasks are made so that the core prints will pass through the sides, the flask being located on the pattern by the fit between the opening in the flask and the core print in the pattern. The core is subsequently located in the mold by the fit between its print and the opening in the flask, thus placing no dependence on the green sand support of the mold for locating the core. Cores which cannot be made in this way are made by casting the baffle separate, ramming it up in the core and casting it into the head.

Patterns For Separator Heads.

The patterns for these separator heads are symmetrical and are parted on a plane passing through the center line of the openings, thus making them ideal for mounting on molding machines. In this case, all the undercuts between the flanges and the bodies can be drawn in green sand.

In the wells for separators, however, and in vertical separators, it is often desirable to make the castings in a vertical position, in which case the undercut between the body and the flange will not draw in green sand. This difficulty is taken care of in the small sizes by means of a dry sand core which carries the flange.

In sizes slightly larger, the flange is loose, the flange pattern being bored to fit the core print. The castings are molded by drawing the flange back out of the drag before rolling over and using a cover core. In some of the larger sizes where the cover cores would be too large to handle, the flanges are made in segments and are drawn back into the mold.

In patterns arranged for molding on jarring machines, the flange is taken care of by a very large core print on the pattern, which is drawn back from the drag before rolling over, the flange being formed by the core which fits this print.

Owing to the greater rigidity of the dry sand core, as compared with

*Presented at the Pittsburgh convention of the American Foundrymen's Association.

green sand, and the relative ease with which these dry sand cores can be blackened and vented, and also on account of the more rigid pattern construction possible, dry sand cores are very extensively used in making this line of work, the cores, as well as the mold being rammed on jarring machines, wherever possible. Smaller parts are made from wood or from iron patterns, as the number of castings required may indicate, and are mounted on the roll-over molding machine.

Ice Breaker.

An interesting casting for a different line of product made by the Harrison Safety Boiler Works, is the drum for an ice breaker. This drum casting is similar in shape to a pulley with a very heavy and wide rim, a hub supported by spokes being required in the center of the casting and a number of lugs and openings are required on the rim for the attachment of the picks which break the ice.

A great deal of difficulty has been experienced in making these castings, by reason of the fact that the setting of the main core displaces the cores which form the openings in the rim and which should cut through to the main core. They are now successfully made with a hollow pattern with a removable end, bored in the center for a spindle. The spindle is firmly held in the mold, the pattern is lowered with the prints for the cores through the rim and the lugs on the rim screwed on from the inside of the pattern.

After ramming, the removable end of the pattern is taken off and the screws holding the prints to the rim are removed. The spindle then forms a guide for drawing the main pattern from the mold, after which the prints are drawn in, the small cores set around the circumference, and the main core is set by using the spindle as a guide. The crab on which this core is rammed is bored to fit the spindle. The box for the main core is parted in the plane of the spokes, and the spokes and the hubs are made loose in the box so that they can be drawn from the core.

There is an indefinite variety of styles, and of sizes of car wheels, and a very large and extensive pattern equipment is required to produce the various kinds of wheels required by steam and electric roads. The Lobdell Car Wheel Co., Wilmington, Del., has a most complete pattern equipment for casting all varieties of wheels, and the arrangement of these patterns, both for changes in the patterns to meet various specifications and for the storage of the many parts required, is an object lesson for any foundryman.

The wheels are listed primarily according to diameter. They are roughly sub-divided as wheels of the type furnished to steam roads, wheels of the type furnished to electric roads and double flanged wheels, such as are used by crane builders.

The wheels for steam roads are further classified as single plate, double plate, Washburn (part single and part double), open plate, wave plate and spoked wheels. These are again classified as having the bearing inside the wheel or outside the wheel and further, according to the weight of the casting.

Under these in turn is an almost infinite variety of lengths of hubs overall and projection of hub to one side or the other, as well as widths of tread, thickness of flange and contour of tread and flange.

Pattern Record.

Each different contour of tread and flange requires its own equipment of chills, the various chills being designated by number. The Lobdell pattern list contains full information, with reference to all of the above points, as well as number and material of patterns on hand and limits of adjustment on the pattern, together with other information which would not be of general interest and will not be referred to here.

It is the universal practice of the Lobdell company in the construction of its patterns, core boxes and flasks to avoid the use of dowel pins as a means of location, all parts being located by turned or planed shoulders. Where dowel pins are used, they serve only to prevent rotation on circular fits.

This is a practice which might well be adopted by foundrymen in general, as the matching of patterns, core boxes and flasks so obtained is far more accurate than can be obtained by means of dowel pins, and owing to the very much larger bearing surface afforded, will remain so for a longer period. The wheel patterns are made of pine, pine mahogany-faced, mahogany, mahogany iron-faced, or wholly of iron, according to the number of castings required.

The hubs, flanges and treads are made as small as the smallest casting required and are turned with locating shoulders into which the various loose pieces fit, making different widths and thicknesses of tread and flange and different diameters and lengths of hubs.

The hub core boxes are made a uniform length and the core prints which are attached to the hubs are made the same length overall, regardless of the length of the hub, the extra length of print in the case of shorter hubs being placed on the drag side so that all cores for hub openings are interchangeable.

The depth of the flange from the parting line on the flange to the position of the gage point on the rail head cannot be varied except by changing the chill, as this portion of the wheel is cast against the chill. It is possible, however, to use different chills with the same pattern and thus vary this dimension.

The depth of the flange from the parting line to the back or side away from the rail can be varied by using different flanges on the same pattern, this portion of the mold being made in sand.

Other dimensions which may vary are distances from the parting line of the flange to the ends of the hub, this being accomplished by changing the hubs on the pattern.

The process of molding car wheels at this plant consists of bolting the chill to the cope flask, laying the pattern into the chill with the cope down and using the cope as a match against which the drag is rammed, after which the whole is rolled over and the cope is rammed in the usual manner.

Molding Car Wheels.

It might appear to the uninitiated that it would not be necessary to fit the pattern to the chill, as this portion of the pattern does not form any part of the mold. As a matter of fact, however, the pattern must be accurately fitted to the chills. Any springing or rocking of the pattern in the ramming process would result in variations of thickness in the rim or flange and, as the castings are used without machining, such variations on this surface would result in the rejection of the wheels.

The chills must also be accurately machined, not only to give the casting the proper contour, but because the inspectors make measurements of the castings to determine the amount of shrinkage, the shrinkage being a check on the physical properties of the metal in the wheel. Inspectors, therefore, demand that the chills be maintained exact to diameter and gage so that this measurement can be made.

What has already been said concerning the variety of patterns, and more particularly the great variety

of changes which must be provided for in each pattern, will give some idea of the problem of storing the patterns and their numerous parts in such a way that any pattern and its corresponding loose parts, required to fill any particular order, can be found without undue delay.

It is the practice of the Lobdell company to divide its pattern storage into sections, arranging the sections according to diameter and general style of wheel and giving each wheel pattern a section which contains all the flanges, treads and hubs applying to this pattern.

This section is plainly marked at the end nearest the main aisle to indicate the patterns contained in that section and attached to the end of each section of shelves, where it will be visible from the main aisle, is a plan of the shelves with the lines denoting various compartments and in the spaces are laid off the numbers of the patterns contained in the compartment. By this method it is possible to instantly locate each pattern without reference to a card index or other filing system.

The cores which form the space between the double plate wheels or the double plate portion of the Washburn wheel, are made in boxes which also serve as core dryers. The surface of these cores, forming the interior of the casting, is not highly finished which makes it possible to construct the boxes in this way.

The box itself forms the lower half of the core and the prints which support it in the mold. The center of the box is bored to a loose piece which in turn centers a strickle which is used to form the upper half of the core. A gage fitting onto the box in exactly the same way as the strickle is then applied to locate the anchors which hold the core in the mold, thus determining the uniformity of the thickness of the plates in the castings.

Another interesting device which deserves more general application, was observed in the core room of this plant. It consists of a guide fitting the top of a core box which is bored for the vent wire so that it guides the wire as it is inserted into the core and insures uniformity of location.

Molding Heavy Fly Wheels

THE practice of molding and casting heavy fly wheels on the floor instead of in a pit, effects a considerable saving in the cost of molding, inasmuch as the bricked-up cheek can be lifted off intact after the curbing is removed, and can be used over again for another casting by merely renewing the loam surface. That the advantages of this practice are widely appreciated is demonstrated by the methods pursued in the foundry of Carel Freres, Ghent, Belgium, where heavy fly wheels have been molded on the floor since 1878, in a manner substantially the same as is practiced in progressive foundries in this country. As might be expected, there are some differences in the details of molding, a comparison of which will prove of interest.

The molding of a large fly wheel necessarily requires considerable floor space and in consequence, much scheming is resorted to, especially in crowded shops, to confine the molding operations to as small an area as possible. This end is attained in Belgium by constructing both cheek and drag on the same floor, using one spindle. In a large shop in this country it is the practice to use two floors, one for the cheek and another for the core, and to utilize the space inside the cheek for sweeping other cheeks for wheels progressively smaller in diameter and as many as three cheeks have been swept in this manner, one inside the other, by the same spindle. Notwithstanding this ingenious conservation of space, however, more room is required when both cheek and core are molded on separate floors, than when only one floor is used, and, in addition, it may not always occur that castings of a form suitable for molding inside the cheek are required at the time this is being made. Therefore, the one floor system has the advantage where floor space is at a premium, and when the demand for the casting is not so pressing that two crews have to work at the same time, one on the cheek of the mold, and another on the core.

One Floor Method.

The one floor method of making a fly wheel is illustrated in Fig. 1, which shows a mold in the last stages of construction. The cheek has been finished and raised out of the way so that work can proceed on the arms and inside circumference of the wheel. The cheek is supported on tripods, about 6 feet high, so that it is out of the way while the inside of the mold is being made. The tripods are formed of three pieces of round bar iron, arranged in a triangle braced at the center by a heavy plate, and fitted at the bottom with a square, flat base of heavy sheet steel, to prevent the tripods from sinking into the floor. The top of the tripod is flat and square, affording a good support for the leveling blocks on which the cheek is supported.

The cheek part of the mold is made first, the plate being placed on the floor with the spindle centrally located. After the cheek has been bricked and the coating of loam applied, it is dried and the blacking is applied. The cheek is then lifted by the crane on top of the tripods, leaving the floor clear for the commencement of the core. About two days is required to make a cheek for a wheel having a straight face, 5½ feet wide and 21 feet in diameter. Both straight and grooved wheels are swept on one floor in this manner, in the foundry of Carel Freres, and fly wheels having as many as 32 grooves, 1½ inches wide, are made.

The loam ridges that form the grooves in these wheels are carried by small cast iron plates, 7 inches long, 6 inches wide and ½ inch thick. The plates are perforated and are sharpened on the outer edges. They are placed between the rows of bricks so as to project inside the circle a sufficient distance to carry the loam which forms the ridge. In Fig. 2 is shown a view of a grooved wheel which was made from an elevation to clearly illustrate the inside circumference of the cheek. Risers are placed on the rim of the wheel at equal distances around its circumference. The gates are shown in Fig. 2. The mold is poured entirely from the hub as it is not considered good practice to cast a fly wheel from the rim, which is sometimes done. The advantage of casting a fly wheel at the hub is due to the fact that it can be more easily fed to avoid shrinkage, as some wheels, particularly heavy rope pulleys, are fed for more than two hours after being cast. It will be noted from the illustrations that the bricks that form the outer circumference of the cheeks are quite thin. This is due to the fact that the grooves are spaced at distances of only 1½ inches and the plates that hold the loam are laid

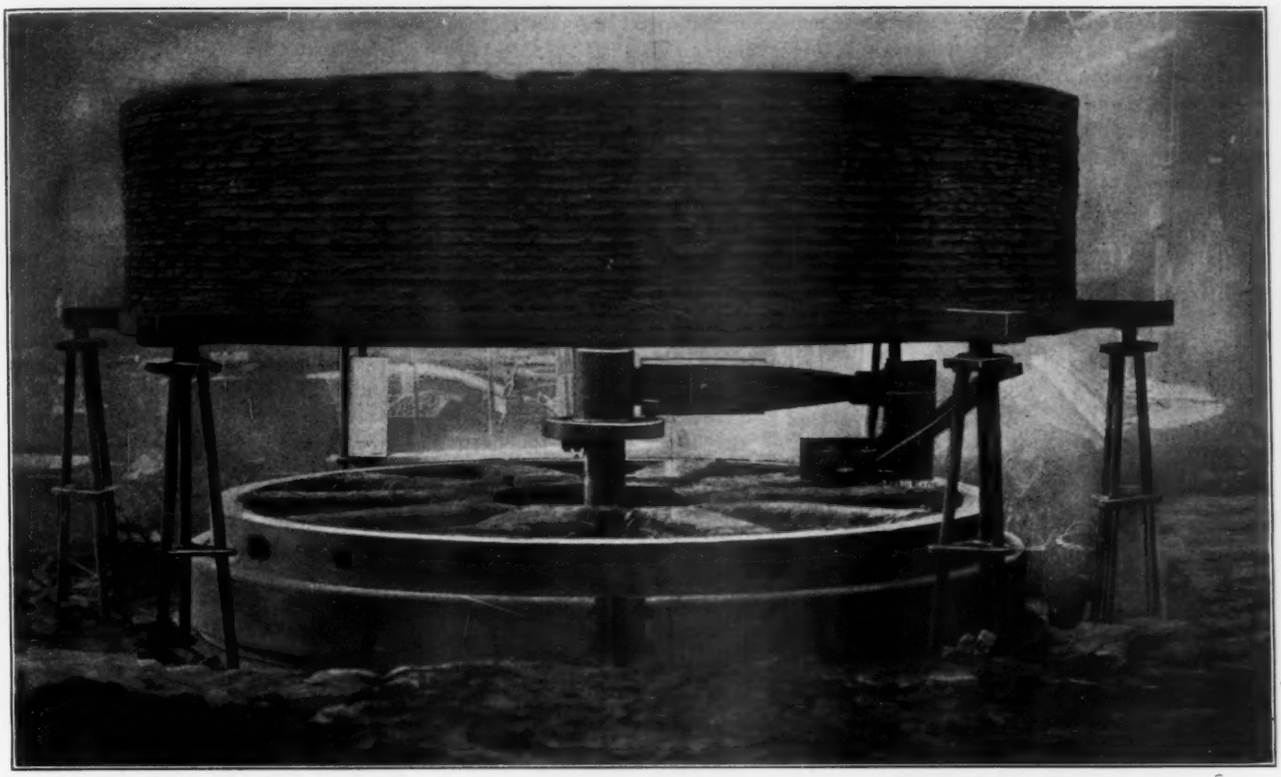


FIG. 1—METHOD OF MOLDING LARGE FLY WHEELS IN A FOUNDRY IN BELGIUM. THE CHEEK IS SUPPORTED ON TRIPODS WHILE THE CORES ARE BEING SET FOR THE ARMS AND THE INSIDE CIRCUMFERENCE OF THE WHEEL

in the joints between the brickwork, therefore necessitating the use of very thin bricks. The arm cores, shown in Fig. 2, are provided with clamping strips on either side at the joint of both cope and drag, the two halves of the core being clamped together, a practice that affords greater security in making heavy fly wheels, and es-

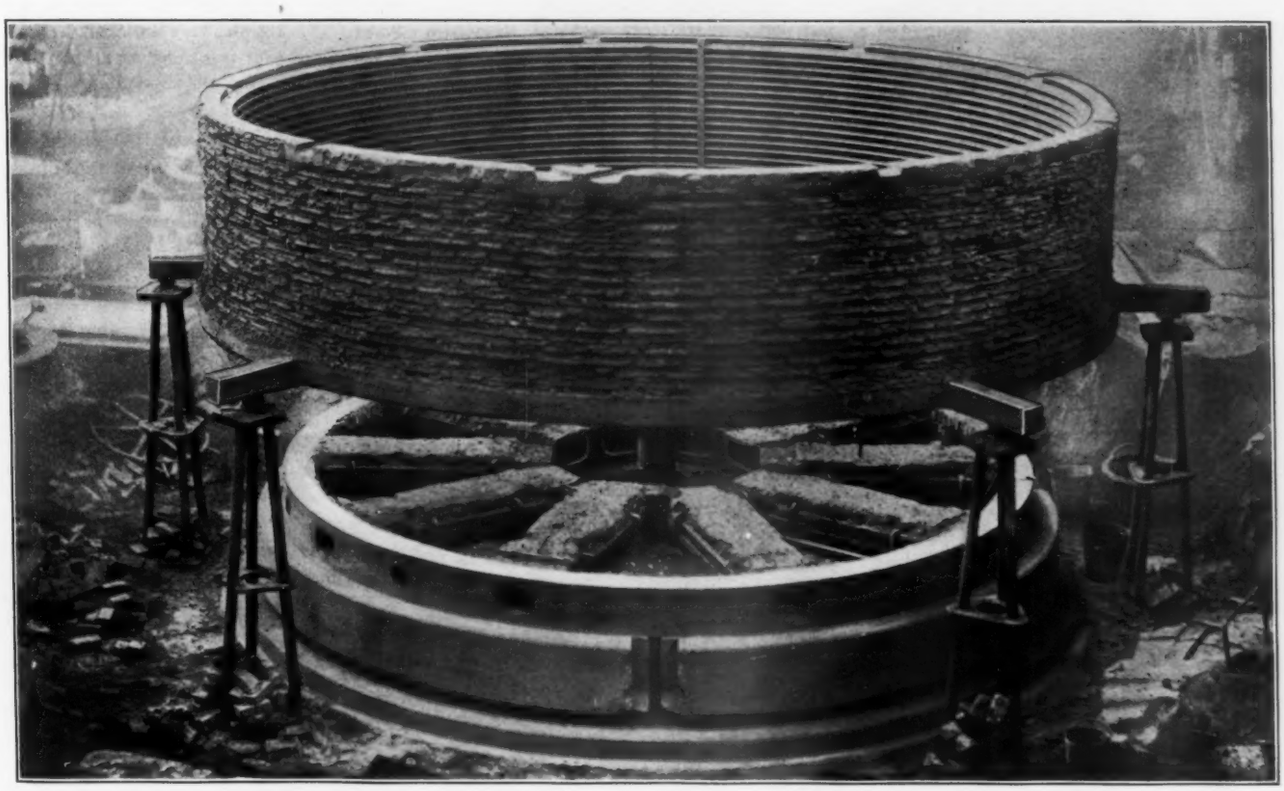


FIG. 2—A VIEW OF THE CHEEK OF A GROOVED WHEEL, WHICH ALSO SHOWS THE GATES

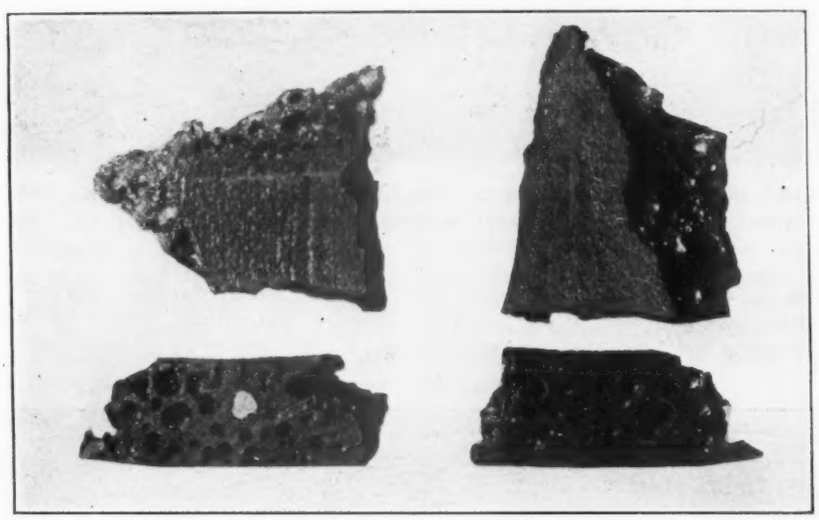
pecially those with two sets of arms.

Fly wheels up to 65 tons in weight are made in this manner. In the case of grooved wheels, the cheeks can only be used once as they are torn down in removing the casting. The cheeks of band wheels can be used for several molds, but in this shop it is not considered economical to do so unless two or three fly wheels of the same type are ordered at one time.

Spongy Iron

By W. J. Keep

Question:—We are experiencing considerable trouble with gas engine cylinders, the iron being spongy in the drag side of the casting and this cannot be detected until after the castings are machined. While we use good grades of northern and southern iron, we do not mix by analysis. One of our 1,000-pound charges is made up of 400 pounds of southern Ohio pig iron, 200 pounds of southern iron and 400 pounds of scrap. Our iron is always hot and we use a good grade of 72-hour low-sulphur coke. While we do not cast the cylinders on end, as is the usual practice, green sand molds are employed. Occasionally a small amount of aluminum is added in the ladle, but not more than ½ pound per 1,000 pounds of iron. In the accompanying illustration is shown a section of spongy iron which was broken from a 1,200-pound cylinder at about the middle of the drag side. The casting appeared perfect when machined and the cope side was sound.



SAMPLES OF SPONGY IRON BROKEN FROM THE DRAG SIDE OF A CAST IRON CYLINDER

Answer.—I rarely ascribe any difficulty to sulphur for the reason that sulphur is made to suffer for practically all of the difficulties experienced in the gray iron foundry. In this instance there is every reason to believe that this iron sponge is the direct result of high sulphur. The probability is that the coke contains more than 0.75 per cent sulphur and it is also probable that the scrap contains more than 0.07 per cent of sulphur. While the analyses of the pig irons used are not given, there is every indication that they exceeded 0.03 per cent of the sulphur. A peculiarity of high sulphur in coke is the variation in the amount that will be assumed by the iron from day to day. In this case the spongy iron was on the under side of the casting. The surfaces of the casting, both against the core and against the mold were almost perfect; therefore, neither wet sand nor faulty cores caused this trouble. Steam or gas generated in the lowest part of the mold would pass out of the riser, or through the vents, and would at least have caused blow-holes on the upper part of the casting. It is evident that the gas was generated after the metal had become too solid to permit the gas to escape from the sulphur spot, nor could this difficulty be obviated by additional venting in the bottom of the mold, as this iron contained a solid skin above and below in this section of the casting. To prevent a recurrence of these spongy spots, careful melting practice should be observed, the scrap should be broken as small as the pig iron, which, however, is rarely done. The first iron, or that which has been longest in contact with the fresh coke of the bed, will naturally be high in sulphur and should not be used for such work as gas engine cylinders. The first charge or two will be high in sulphur, owing to the fact that the hearth of the cupola is cold. It is also evident that in charging better results can be obtained by a more thorough mixing of the pig iron and the scrap, that is, charging two pigs of one grade, one pig of another and two or more pieces of scrap of such weight as prescribed by your mixture. If you are producing large castings in your foundry and only have a small cupola, a mixing ladle should be used in which the iron is cast as fast as it is melted. One-half pound of ferro-manganese should be placed in the ladle before the iron is tapped out. Aluminum removes the oxygen and prevents blow-holes, but it is of no value for removing spongy spots caused by sulphur. The sample of spongy iron has been cut and it is evident that the iron is too soft for cylinder purposes. Pig iron should be used that will give a closer grain and the percentage of scrap should be increased.

Soft Iron for Pole Shoes

By N. W. Shed

Question:—In the magneto which we manufacture the pole shoes are made from cast iron which we aim to have as soft as possible, not only for easy machining, but also for its high magnetic properties. Our present mixture analyzes as follows: Combined carbon, 0.374 per cent; graphitic carbon, 2.90 per cent; silicon, 2.854 per cent; sulphur, 0.071 per cent; phosphorus, 0.812 per cent, and manganese, 0.063 per cent. We would like to know what should be added to this iron to make it softer.

Answer:—This iron could be made to run higher in graphite. If the graphite were 3.30 per cent, the iron would be much softer. It is hardly possible to increase the silicon and to thereby gain very much of the graphite content. Silicon itself is a hardener, but it acts up to 3 per cent as an agent to increase the graphite and thus its total effect is to soften the iron. If manganese were added to this iron it would have a tendency to reduce the sulphur and thereby reduce the combined carbon, thus increasing the graphite. It might be advisable to add ferro-manganese to increase the manganese content to 0.50 per cent. If this iron is melted with a slight excess of coke some carbon would be absorbed by the iron and if the blast is light there will be little oxidation. Very slow cooling increases the percentage of graphite and if the castings are made in dry sand and left in the molds the graphite will be increased.

THE BRASS FOUNDRY

Casting Bronze Screen Plates

SCREEN plates are merely slabs of bronze, ¾ inch thick, 10 to 12 inches wide, and of a length that may vary from 24 inches to a number of feet. They are used in paper mills, and the castings appear simple to make, but are often found to be the source of much trouble and anxiety, when improperly molded, gated and poured. The chief difficulty is to obtain clean plates. This trouble increases with the size of the casting, as the metal has farther to travel and has a greater opportunity to collect dirt. The molds are usually made of green sand, and different methods of gating the castings prevail. Sometimes they are run from one end only, from the side, from either end, or from both the sides and ends, according to the length of the plate, and the practice that prevails in the shop in which they are made.

Importance of Rapid Pouring.

The important feature of casting these sections is to get the metal into the mold as quickly as possible with the minimum amount of travel. A plate, four feet long by 12 inches wide, is frequently run from one end. Fig. 1 is a section of a mold for one of these plates, ready to pour. It will be noted that the flask is inclined considerably, so that the metal travels down hill in filling the mold. A riser is not essential, although it possesses the advantage of relieving the strain on the mold, and may serve to carry off any dirt that may be pushed ahead by the metal. If a riser is used it will need a built-up head, that will equal in height the upper end of the mold; otherwise, owing to the inclination of the flask, the mold would fail to fill. Attention is directed to the method of gating adopted in this instance, which is shown in greater detail in Fig. 2. It will be noted that the gate is molded in the cope. A set gate is used, which is placed about 1½ inches away from the end of the pattern. The channels connecting the gate and the casting are cut in the drag of the mold and are broad and thin, to choke back any dross or dirt that may escape the skimmer, and to allow the metal to enter the mold in a broad thin sheet, practically continuous across its width.

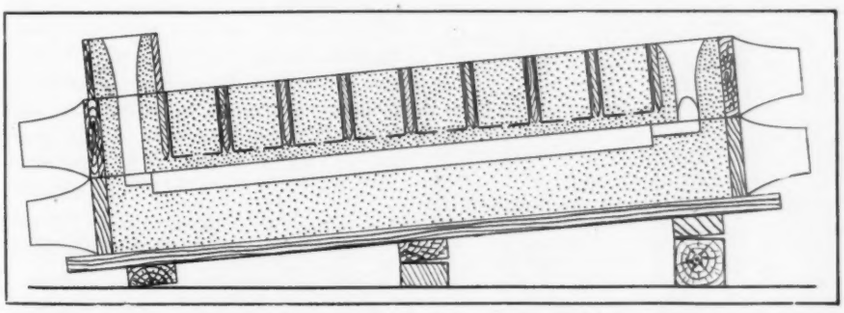


FIG. 1—LONGITUDINAL SECTION OF A SCREEN PLATE MOLD READY TO POUR

While these castings are usually molded from a loose pattern, they can be easily mounted on a board, and it is advisable to adopt this method even when only a few castings are required, as it effects considerable economy in molding. If the plates are made in large quantities, a metal match-plate is to be preferred to a wood plate, and on account of the size and weight of the pattern, aluminum is the most suitable metal to use for this purpose. When wood is used for the pattern plate, it will be necessary for it to be made in such a manner that it cannot warp, as this is the most important advantage that a pattern plate or board possesses over a loose pattern, and it effects a greater saving of time than the elimination of joint-making and gate-cutting.

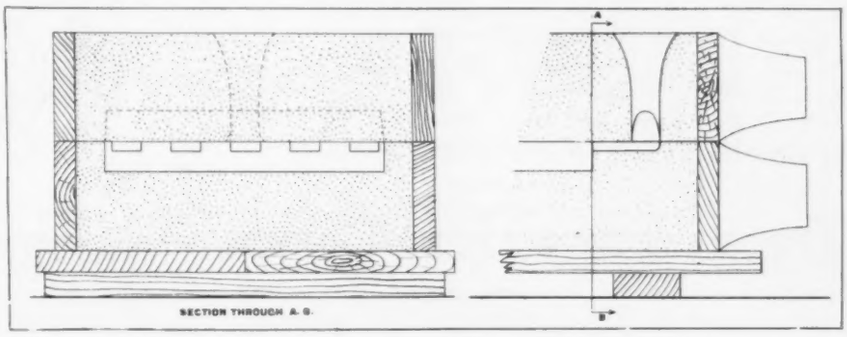


FIG. 2—SECTIONS OF A MOLD FOR A SCREEN PLATE SHOWING DETAILS OF GATING

A loose, wood pattern, four feet long, 12 inches wide and ¾ inch thick, no matter how carefully made, will generally spring slightly when the drag is rolled over. This renders necessary the use of weights on the pattern while the joint of the mold is being made. After the weights are removed, the pattern springs up above the joint again, and in so doing tears away the sand. If it is not forced back into position when the bars are tucked on the clamped drag, the casting will be a trifle thicker than it should be. As all this trouble can be avoided by attaching the pattern to a plate in addition to the time saved in mak-

ing partings and cutting gates, the economy of mounting the patterns is obvious.

Importance of Soft Ramming.

There are several points to which attention should be directed in molding these plates. One of the most important of these is the manner of ramming the drag. The softer this is rammed the better, providing the casting does not swell. Swelling can be avoided and the mold rammed sufficiently soft to produce good castings without the necessity of venting, if the sand is packed firmly around the sides by peening all the way up in the drag and by packing the sand in the center over the pattern, with the hands, until the drag is filled and ready for butt-ramming. Then it should be lightly rammed above the pattern, and vigorously rammed around the sides. This method of ramming allows the gases and steam to escape between the bottom board and the flask. This will prevent scabs, which are always fatal to such castings. Screen plates are machined on both sides and are slotted, the slots being close to each other and extend through the plate. The slots are V-shaped and terminate in a very narrow opening which is cut through the bottom of the slots by a circular saw. These slots form the screen, hence the name of the plate, and the latter is used in grading the paper pulp to standard size.

The surface of the plate must be smooth and straight, without imperfections of any kind, and as the minimum amount of stock is machined off, it is essential that the castings be clean. Owing to the large amount of machine work required on these castings, the metal used in making them generally carries a considerable quantity of lead. The better quality of plates contain considerable tin, sometimes as much as 12 per cent, but the cheaper plates are made from scrap. An average mixture follows: Copper, 86 pounds; tin, 6½ pounds; zinc, 3½ pounds, and lead, four pounds.

Deoxidizers for Copper Alloys

By C. Vickers

WHEN copper is raised to a red heat it possesses such a powerful affinity for oxygen that an external coating of oxide or copper rust is formed. If the heating is continued and increased to the melting point of the copper, the coating of oxide may become so thick that the metal in the interior may become liquid and run out, leaving a shell the form of the original piece of metal. If the shell thus formed is stirred into the melted portion it will be absorbed and held in the metal, which thus becomes a mixture of dross and copper, greatly inferior in strength and other qualities to the original metal and which will produce spongy castings.

To reduce oxidation to the minimum the metal, whether copper, brass or bronze, is never allowed, in well regulated shops, to melt down without attention, but every effort is directed towards bringing it to a melted condition with the minimum amount of exposure to the atmosphere or furnace gases. Therefore, when melting commences, the metal is pushed down into the melted portion of the metal as soon as possible and the surface of the bath is always kept covered with charcoal. Notwithstanding these precautions, however, enough oxygen is always absorbed by copper to make it impossible to obtain sound sand castings without some preliminary treatment of the metal. This treatment may consist of a reduction of the oxygen by poling or stirring with a stick of hard wood, or by the addition of zinc, phosphorus, silicon, magnesium, or other elements of similar effect.

Poling or stirring must generally be supplemented by the addition of some deoxidizing element, such as silicon, etc., to eliminate porosity, although a smaller amount of the deoxidizer is required when the metal is so treated. The various elements which have been mentioned and others, such as manganese, iron, sodium, etc., are known as deoxidizers and their application in brass foundry practice is comparatively recent. By their use alloys have been greatly improved and adapted for many purposes for which they otherwise would have been unfitted. On the other hand, they are also responsible for many difficulties with which the modern brass founder has to contend, and in this article the effects of the various deoxidizing elements on the external appearance of the castings will be dealt with, in order to give some idea of what may be the cause of the difficulty when trouble is encountered due to some impurity which may have accidentally entered the metal.

Phosphorus is probably the best known and the most generally used of all the deoxidizers. It was first used in copper and brass by Parkes of Birmingham, Eng., who took out patents covering its use in 1849, but its value in copper and tin alloy was not understood until a much later date. Phospher bronze was first made commercially in 1873, as a result of the investigations of Montefiore, Levi and Kunzel, and since that time the use of phosphorus has been firmly established.

Phosphorus.

The external effects produced by phosphorus on castings vary according to the quantity used, but when the percentage of phosphorus is high the castings will be black in color, and the metal so fluid that it will soak into the sand. Consequently, if some precautions are not taken to prevent this by making the mold impervious to the metal, or by pouring the metal near the congealing temperature, the castings will be so rough as to be often unrecognizable. When phosphor bronze is cast, the difficulties encountered, other than those arising from excessive fluidity, are due to the slag which is continually rising to the surface of the metal in the crucible and is very difficult to skim off. Therefore, some form of skimming gate should be adopted, whenever possible, in pouring these alloys, to prevent the slag from entering the casting. In the case of very heavy castings, even after every precaution has been taken, defects may frequently be found on the upper parts of the castings, due to the formation of little slag pockets. This may be largely overcome by pouring as cool as possible and letting the bronze stand in the crucible until cooled to the proper temperature. This is preferred to cooling by the addition of gates, etc., so that as much slag as possible may rise to the surface before the metal is poured. Phosphorus in scrap metals may sometimes cause inconvenience, but it is by no means as harmful as some of the other deoxidizers.

Iron.

Iron is generally an accidental impurity in modern alloys, although sometimes it is used intentionally. It is not generally classed as a deoxidizer, although it can be used as such in the form of tin plate or yellow prussiate of potash. Its effect on brass castings is well known. It produces an unsightly black color and undue shrinkage when used to excess. In this case prevention is better than cure, and the iron should be removed

before the brass is melted, whether in the form of chips or scrap metals. When iron finds its way into the metal accidentally, the castings must be scrapped if much machine work must be done on them, or if fine finish is required. The metal can only be used by mixing it again with new metal or by running it into cheap castings.

Aluminum.

Bronze or composition castings contaminated with aluminum, possess a disagreeable, bright bluish white color and when this is removed by dipping or tumbling, dark spots are frequently faintly discernible which, when machined, will often turn out to be blow-holes under the skin. The metal will be found more difficult to machine, as the effect of lead in the mixture to produce short chips is counteracted to a large extent and the castings will often be drossy and porous. In the case of yellow brass, aluminum is extensively used for the production of small, thin castings, such as saddlery hardware, refrigerator trimmings, plumbers' ferrules, etc., as it promotes fluidity, suppresses zinc oxide smoke and permits the use of an increased quantity of zinc in the alloy, thus making it possible to use a cheaper metal with superior results.

To obtain these results only a small quantity of aluminum is required, and this generally amounts to a fraction of 1 per cent. Only sufficient aluminum is used to produce a bright, pale gold color on the castings, and even this amount cannot be used if the castings are to withstand high pressures, as the aluminum will cause the castings to leak. It is liable, also, to cause drossing adjacent to the gate, especially if the castings are at all thick in section, so that the use of aluminum, even as a flux or deoxidizer in yellow brass, is limited. If used in larger quantities, and the alloy is leaded, the gold color will be turned into a dark, bright blue, verging on purple in spots, and the metal will be so rotten that it can easily be broken, revealing large crystals when fractured. When this occurs, either by design or by accident, the metal cannot be brought back to its original condition by remelting, but must be used cautiously with new metal. Aluminized brass is very difficult to use in a satisfactory way, as heats of new metal are ruined by a very small percentage, and 10 pounds of yellow brass or manganese bronze containing one-half of 1 per cent of aluminum is all that can be safely used in 100 pounds of red metal.

Aluminum, therefore, should be carefully excluded from all brass or bronze castings, with the exception of small, thin, yellow brass work, such as previously mentioned, otherwise much annoyance and loss may result. Accidents, however, will happen occasionally and some of the ways by which this metal may be introduced into alloys where it works harm, are by the use of scrap containing aluminum, such as manganese or aluminum bronze, which cannot readily be detected. Carelessness however, is probably the most frequent cause of losses from aluminum in castings and when aluminum castings are made together with brass and bronze in the same shop, the use of skimmers and furnace tools previously used for aluminum must be constantly guarded against, as the latter metal sticks to the tools in a thin film, which is sufficient to cause considerable trouble. Aluminum cannot be fluxed out of bronze or brass in the foundry, and the only way to use it is to proportion it with new metal.

Silicon.

Silicon is a product of the electric furnace and is used in the brass foundry in the form of an alloy with copper, known as silicon-copper. It is extensively used as a deoxidizer for making copper castings and is very effective, producing fine castings of a deep red color, very soft and ductile and of much higher conductivity than is possible with zinc or phosphorus.

In bronze, however, its range of usefulness is curtailed more than aluminum, as it cannot be used in alloys that contain lead, whether yellow brass or bronze. When no lead is present, however, both bronze and brass cast well and silicon is occasionally used for making trolley wheels, either with copper or in combination with tin. The external appearance of yellow brass castings is similar to that produced by small percentages of aluminum, when lead is not used. The presence of lead, however, imparts to the castings a white coating when taken from the sand, and when this coating is removed by brushing or tumbling, the surface of the casting will be found to be pitted with innumerable holes filled with a white powder. The same effect is also produced on bronze when lead is present and a very small quantity of silicon will cause this result. The percentage may even be so small that the castings fail to show the white coating, and merely leave a white impression behind them when removed from the sand. A closer inspection, however, will generally reveal superficial dirt spots on the surface of the castings and these, when machined, will frequently turn out to be blow-holes.

This difficulty is not as likely to occur accidentally as the difficulties caused by aluminum. When it does happen, the appearance of the metal when molten will be similar to that caused by the presence of aluminum and the casting qualities as regards fluidity will be the same. When the castings are poured into sand molds, aluminum will impart a lustrous, bluish white color that can only be removed with difficulty by long tumbling or pickling with acids, while silicon produces a chalky coating that may be rubbed or brushed off, and in this way the trouble maker can be detected. Silicon, therefore, should never be added to scrap metal as a deoxidizer, as it is liable to cause trouble and loss and its use should be confined to making strong, high zinc alloys, free from lead and for making copper castings.

Manganese.

Manganese imparts a brown color to castings, which will vary in depth according to the quantity of manganese used. It also interferes with the fluidity of the metal so that the castings are filled with cold shuts. This may be corrected by the addition of a very small percentage of aluminum, or by phosphorizing the metal. When scrap contains manganese no trouble results, unless the percentage is sufficiently high to cause cold shut castings, and this is easily corrected by either aluminum or phosphorus.

Magnesium.

Magnesium, in large amounts, imparts a black color to the castings and so affects the fluidity that the alloy will not fill the mold. It is not found in scrap brass in sufficient quantity to cause any trouble, and when added as a deoxidizer must be used in small doses, otherwise its effests will be harmful.

The *Mechanical World* electrical pocket book for 1912, recently issued and published by Emmott & Co., Ltd., 65 King street, Manchester, Eng., has been thoroughly revised and the new sections included treat of the following subjects: Electric lamps, electric lighting, motor starters, static transformers, construction, rating and testing of high tension apparatus, aluminum cables, etc. The contents include a varied collection of electrical engineering notes, rules, tables and data especially prepared for the use of those in charge of electrical plant or machinery.

Brass Foundry Difficulties

SOLVED BY EXPERTS

Crucible Difficulties

We recently installed a tilting furnace which takes a 400-pound crucible. We melt with crude oil and experience no trouble in melting the metal, but we do not get satisfactory service from the crucibles as they only average ten heats and cost $25.80 in our section of the country. We are very careful in handling the pots, as we anneal them for about 30 hours, maintaining a slow fire for the first 24 hours, finishing with a hot charcoal fire. We set the crucibles mouth up in the annealing furnace and do not reverse them. When charging the pots we are careful to prevent bursting them by packing the metal too closely and we allow ample clearance at the tops. We have been using a blacking made from ground crucibles and fire clay, which is applied in a thick coating to the crucibles while warm. This is done to protect the pots and to lengthen their life. Do you think this is good practice? We would also like to know how to judge whether we have an oxidizing or a reducing flame in the furnace. The crucibles break around the bottom.

Probably the crucibles you are using are not adapted for melting with oil, but are intended for a coke furnace. This may be one reason they are giving unsatisfactory service and we suggest that you correspond with the manufacturer and ascertain if such is the case. Crucibles can be obtained that are especially made for use with oil. The fact that the crucibles break around the thickest part at the bottom, suggests another possible reason for their failure. This trouble is frequently due to the use of too small a base, which permits the bottom of the pot to be pushed up when it becomes softened by the heat and causes a leak in the thickest part of the crucible. When this difficulty occurs the pot will usually begin to expand below the bilge several heats before failure occurs, and if you have noticed any such expansion it may be taken as an indication that the base is at fault. The base should be fully as large as the bottom of the crucible, so that the walls of the pot as well as the bottom are supported. Otherwise, the bottom will certainly be pushed in by the weight of the metal, when the pot becomes soft. It is good practice to use protective coatings on the pots. We suggest that you use a coating consisting of finely sifted carborundum fire sand in the proportions of five parts, with ground crucibles two parts, and three parts of crucible clay; the mixture is converted into a batter with water and silicate of soda. This wash should be brushed onto the crucibles when they are cold, after which the pots should be dried gradually. The wash should be applied after the pot has been used for melting, and not before its initial heat. The presence of smoke is usually considered as an indication of a reducing flame, as it shows there is an excess of carbon, and if you desire such a flame in your furnace the air should be regulated accordingly.

Anti-Acid Metals

We are experiencing some difficulty with the anti-acid mixture we are now using. It is a combination of copper, lead and tin. Can you furnish us a good formula for a metal of this description, that would be suitable for mine pumps?

There is no alloy of copper that is absolutely anti-acid, as they are all attacked by acids to some extent. A good alloy for this purpose, known as an anti-acid metal, is composed of copper, 86¾ pounds; tin, 10 pounds, and lead, 5 pounds. If you have not tried this alloy we suggest that you do so, as it will be found more resistant to acidulated waters than the more highly leaded alloys. Alloys of nickel and copper, in which the former metal is in sufficient quantity to blanch the metal, are more non-corrosive than the copper-tin series, but they are also more difficult to cast. The same applies to the copper-manganese alloys in which the content of the latter metal is sufficiently high to produce a white metal. This alloy contains at least 16 per cent of manganese, with 10 per cent of zinc, 10 per cent of lead and the balance copper. For small castings, probably the manganese or nickel alloy would be satisfactory, but for heavy castings, molding difficulties might be encountered, unless you can command the services of molders skilled in the casting of these alloys. As a last resort you might try the following alloy: Copper, 88 pounds; tin, 8 pounds; nickel 3 pounds, and phosphor-copper, 1 pound. Charge the nickel first, with the copper on top, and melt the two metals together; then add the phosphor-copper, followed by the tin and stir thoroughly. If considerable machine work is required on the castings, 3 pounds of lead may be added to replace an equal amount of copper.

Use of Copper Scrap

We have an unlimited supply of copper ingot scrap of the following analysis: Copper, 97.58 per cent; nickel, 2.35 per cent; aluminum, 0.03 per cent and iron, 0.04 per cent. We would like a mixture in which we can use this material that will be suitable for casting gears, and crane bushings. The gears are used on lathes and are subjected to heavy duty; they are about five inches in diameter with five-inch face. Any mixtures in which the alloyed copper can be used will be appreciated.

Although the percentage of aluminum in this alloyed scrap is very small it is a disturbing factor and may cause casting troubles when the copper is used for making bronze. A trial, however, will determine this point. The iron can be ignored and the nickel constitutes an improvement. The following mixture will be found excellent for the gears: Copper ingot scrap, 90 pounds; tin, 7 pounds, and zinc, 3 pounds. A small heat should be first tried and if the aluminum does not show on the skin of the castings, its presence will do no harm; but if it shows, producing a bluish silvery skin, it will be advisable to use the following alloy: Scrap ingot capper, 57 pounds; manganese copper, 2¾ pounds; zinc, 40 pounds, and aluminum, ¼ pound. For bushings a suitable alloy follows: Scrap ingot copper, 70 pounds; lead, 15 pounds, and tin, 5 pounds. In this alloy the influence of the small amount of aluminum present in the scrap copper will be negligible.

UNIVERSAL BOARD FOR SPLIT PATTERNS*

Adapted for mounting patterns for jarring machine use—Process simple and economical

By A. E. McClintock

ONE objection, frequently made by foundrymen, to the mounting of patterns which are to be molded on jarring machines, is that the number of pieces to be made from each model is usually small and for this reason the pattern cannot be economically mounted on a board. In the foundry of the Wm. Sellers Co., Inc., Philadelphia, a universal pattern board has been devised to facilitate the mounting of split patterns for jarring machine use. This pattern board, mounted on I-beams, which rest on the jarring machine table, is shown in Fig. 1. Both halves of any split pattern can be mounted on this board in less than two hours and it has been found that the pattern for only one mold could be mounted economically.

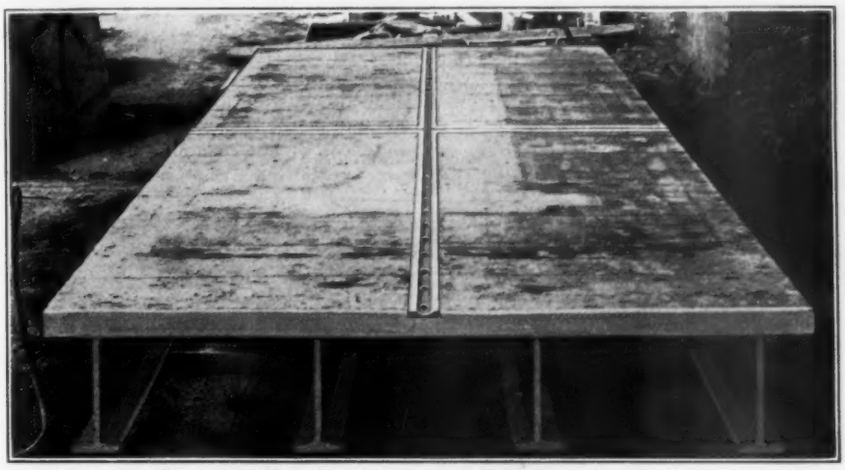


FIG. 1—UNIVERSAL PATTERN BOARD ON A JARRING MACHINE UPON WHICH ANY SPLIT PATTERN CAN BE MOUNTED

Extending through the center of this universal pattern board, both lengthwise and crosswise, are two grooves which form the center lines and in which holes are provided for the flask pins. Fig. 2 illustrates the method of mounting one-half of a split pattern. This shows the cope half on the pattern board. The flask is set over the pattern, the pins engaging in the holes in the board. The pattern is then moved into position in relation to the flask bars and the flask is then carefully lifted off without disturbing the pattern. Small, flat steel strips, suitably bent, and which accurately fit the grooves, are set into the grooves at the points where the pattern crosses the latter and the edge of the pattern is marked with a sharp instrument on either side of the steel strips. The pattern is then turned over, flat side up, and a straight edge is utilized to carry the lines across the flat part of the pattern. These steel strips are then screwed onto the pattern to center it for both grooves, which will serve to locate the pattern accurately on the board.

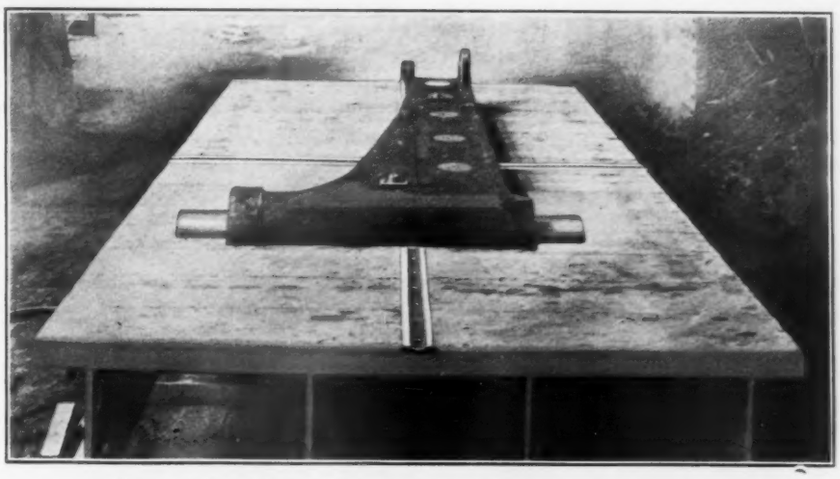


FIG. 2—COPE HALF OF A PATTERN LOCATED ON THE BOARD

Fig. 3 illustrates the next step, which consists of transferring the lines locating the centering steel strips from the cope half to the drag half of the pattern. In this view the cope has been set over the drag pattern and the location of the steel strips on the cope are accurately transferred to the drag. The steel strips, which have been screwed onto the cope, are clearly shown in this illustration. The drag half of the pattern is then turned over and the steel strips are screwed onto this part of the pattern.

In Fig. 4 the steel strips are shown screwed to the flat sides or parting lines of the two parts of the pattern. This entire operation rarely requires more than two hours and on plain patterns these steel strips can be located much more quickly. Regardless of the irregularity of the pattern, this method will centrally locate both cope and drag halves on the pattern plate.

Fig. 5 shows one-half of the pattern located on the pattern board by the steel strips, which engage in the grooves. The flask is then set over the pattern in readiness for the molding operation. Fig. 6 shows the flask clamped, filled with sand ready for the jarring operation. The clamp used in this foundry is unique and can be used for flasks of practically any width or height molded on this jar-ramming machine. It will be noted that the screws, which are fitted with hand wheels, hook under the jarring machine table and fit into

*Presented at the New York meeting of the National Founders' Association.

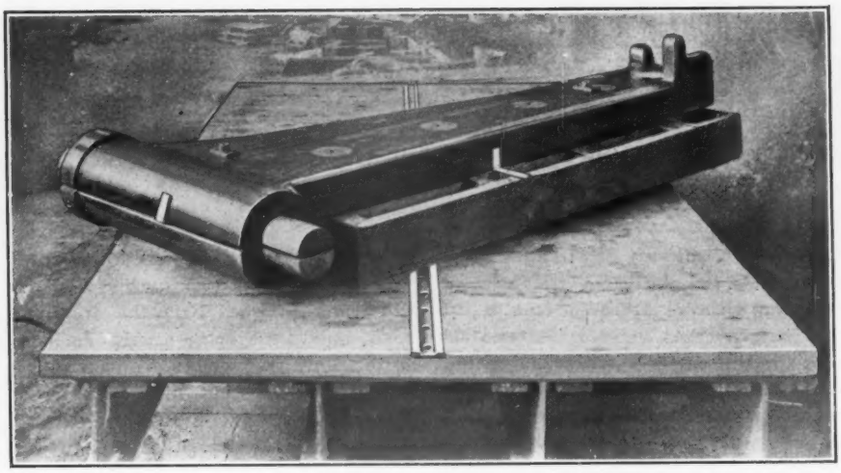


FIG. 3—COPE AND DRAG HALVES ON THE BOARD, SHOWING TWO OF THE STEEL STRIPS WHICH LOCATE THE PATTERN

the slotted ends of a cast iron or steel bar which extends across the flask. In a measure, this forms a strap which is removed from the flask immediately after ramming. In Fig. 7 is shown a view of the mold after striking-off. The hooks, which are inserted in the pattern and are secured in the top of the mold so as to lift the pattern with the mold, are clearly shown in this illustration. The flask with the pattern is then lifted from the table, the pattern is drawn by hand and the mold is finished. The cope half of the mold is shown in Fig. 8 and at the left of Fig. 9 is shown the drag half, which is likewise molded on the jarring machine in a manner similar to that followed in making the cope. The casting made in this mold is illustrated in Figs. 11 and 12, the former showing the cope side and the latter the drag. The smooth surfaces of both sides are particularly striking and reflect the excellence of jar-rammed work. The castings, as illustrated, have just been shaken-out and have not yet been cleaned. The section is a swinging arm for a 60-inch radial drill. The only skilled labor employed was in the finishing of the mold, while the setting of the core and the balance of the work was performed entirely by handymen.

Fig. 10 shows the method of weighting large molds in the Wm. Sellers' foundry. The weights which are set over the mold, both lengthwise and crosswise, are cast iron and were especially designed for this work. The additional weights shown on top of these channels have bars cast-in directly underneath their collars to facilitate handling by crane. The bearing surface of these weights is unusually large.

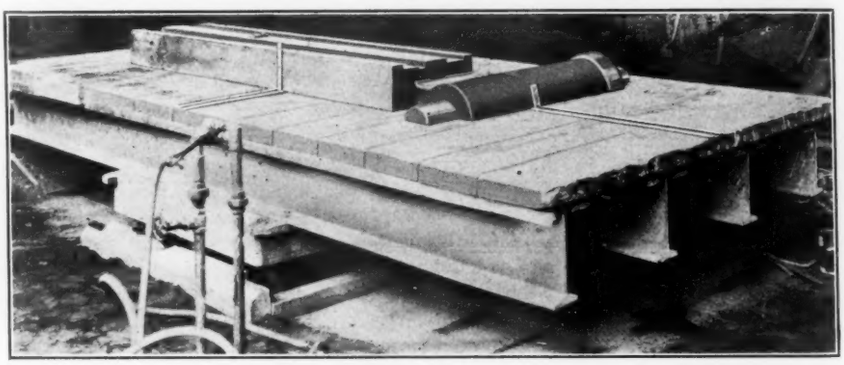


FIG. 5—PATTERNS ON THE BOARD BEFORE THE FLASK IS SET IN POSITION

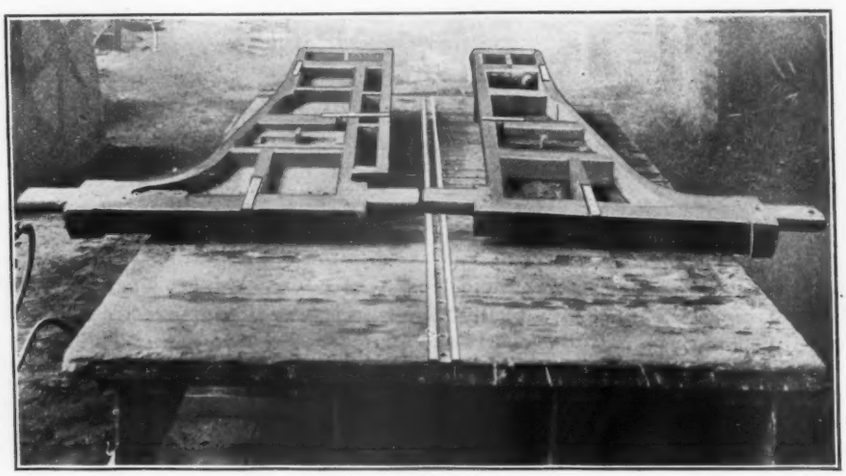


FIG. 4—TWO PATTERNS, SHOWING THE LOCATING STRIPS WHICH FIT IN THE GROOVES ON THE BOARD

Thin, Detached Skin On Malleable Castings

By Richard Moldenke

Recently the writer received several samples of malleable iron in the condition received from the anneal and before soft rolling, which had a thin skin of iron lightly adhering t them. This could readily be stripped off and was examined under the microscope. The problem presented was an explanation of the occurrence with a request for suggestions for means to overcome this difficulty. In the course of many years experience with malleable work, the writer on only a few occasions saw this phenomenon, although rarely was the skin as heavy and as continuous as on the samples received. Usually, the deposit, if it may thus be termed, consisted of a thin network of iron threads of lace-like structure. Soft rolling generally removed this deposit without difficulty, although occasionally it could not be removed in this way and thereby prevented the cleaning of the surface underneath.

The cause of the formation of this skin is difficult to explain. The microscope reveals the fact that the apparently solid skin of iron is interspersed with occasional voids lined with needle-like crystals. These, however, are not of the so-called pine tree variety found in shrinkage cavities and do not seem to be caused

by the molten iron. The fracture of the skin is white and indicates burnt iron. The amount of skin available was too small for analysis, which would have showed whether it was a part of the casting or a subsequent deposit. If malleable iron manufacturers can obtain a sufficient amount of this skin for analysis it might be advisable to ascertain whether its composition approaches that of the castings or the packing material.

Annealed Test Bars.

Many annealing experiments have been made by exposing special test bars in boxes, packed in various ways required by these tests, all of which resulted in interesting developments. One box, when opened, and after the packing was carefully removed, showed the test bar coated with a fine deposit of lamp black, evidently due to the breaking up of gases, rich in carbon, or the plain migration of the carbon from the casting. The writer does not know positively which of these caused the lamp black deposit nor whether other reasons can be assigned as the cause of this phenomenon. The admixture of chemicals in capped pipes in which the test bars had been placed and packed in oxide of iron always resulted in the evolution of a gas which, coming from a small vent hole, would burn a bright yellow for a long time. In these tests the only carbon was contained in the test bars and in a smaller degree in the malleable iron.

These and other developments led the writer to believe that possibly there might be a reaction between the carbon leaving the skin of the hard casting and the oxide of iron of the packing, thereby making the well-understood iron sponge of the blast furnace. The fact, however, that the whole atmosphere was an oxidizing one made this seem impossible. When it was noted, however, that the skin referred to always appeared when there was a heavy percentage of extremely fine packing material in the piles, it seemed more plausible, as a sufficient amount of this material, densely packed, might prevent the oxidation of the iron formed by the reaction of the carbon of the casting with the fine iron oxide immediately touching the casting.

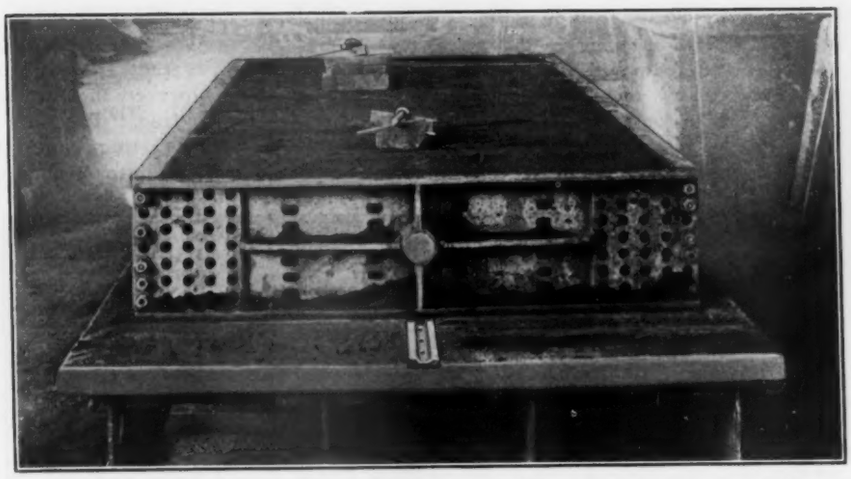


FIG. 7—THE MOLD STRUCK-OFF, SHOWING THE HOOKS FOR LIFTING THE PATTERN

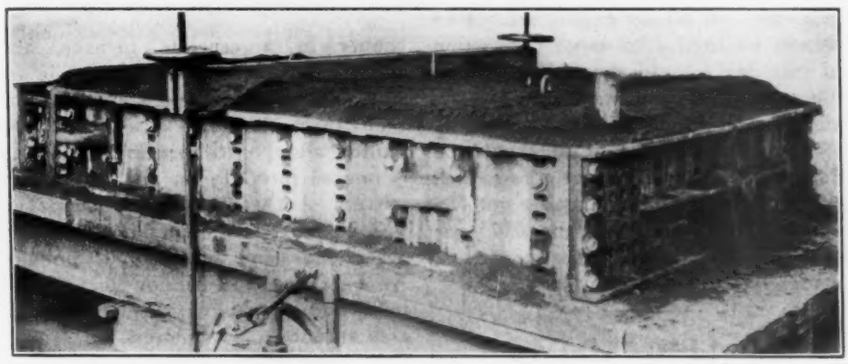


FIG. 6—THE FLASK CLAMPED READY FOR JARRING

At any rate, it seemed to the writer at the time he was investigating these problems in his own works, that if the above theory had some basis of fact, the removal of the extremely fine packing material from the piles by screening would obviate the difficulty. This proved to be the case and it was a rule of this establishment, owing to the accumulation of packing material through the use of pot flakes for this purpose, to keep the piles fairly free from fine dust. Therefore, the occasions for observing the skin on malleable castings were not frequent.

Early Experiments.

An interesting reminiscence might well be referred to in this connection. In the early days of malleable practice, Geo. C. Davis, of Philadelphia, published memoranda in which he gave results which showed that some hard castings, instead of losing weight in the anneal by the removal of the carbon, etc., actually became heavier. Unfortunately, the writer no longer remembers the explanation assigned for this by Mr. Davis, as these investigations were carried on a number of years ago. At that time, however, the rank and file of malleable manufacturers and metallurgists doubted the accuracy of the observations and sought an explanation in the possibility of an oxygen addition to the

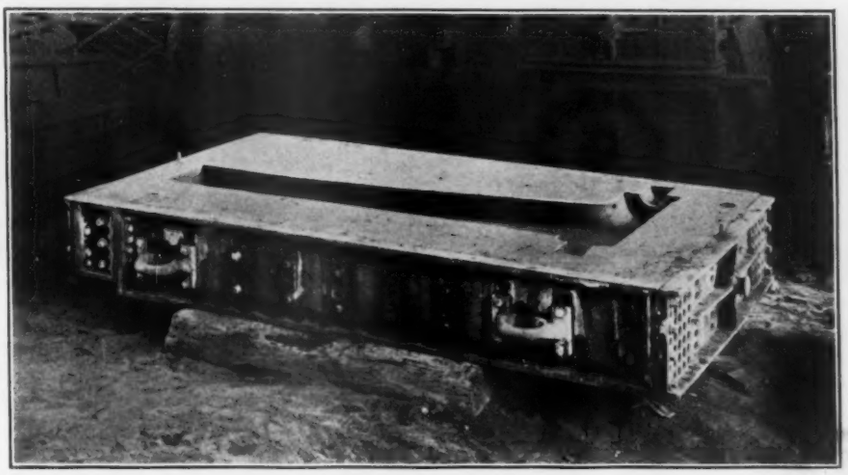


FIG. 8—THE COPE HALF OF THE MOLD

castings which accounted for the weight increase in view of the possibility of the reduction of iron from the packing by the carbon in the castings. The conditions being favorable, this might have caused the increase in weight noted by Mr. Davis.

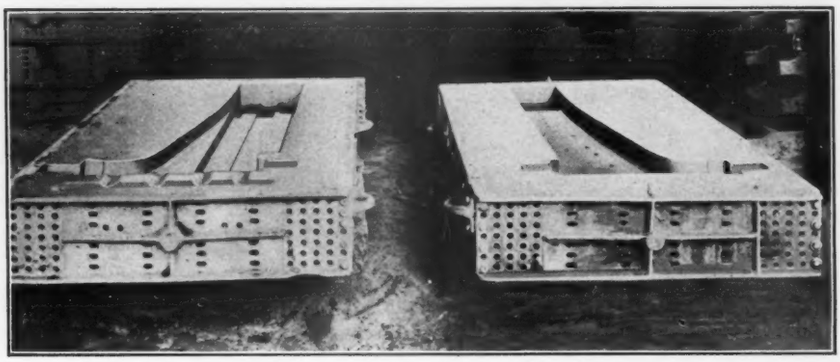


FIG. 9—DRAG AND COPE HALVES OF THE MOLD BEFORE DRYING

Strength and Silicon

By W. J. Keep

Question.—We are engaged in the manufacture of shears for cutting sheet steel. Recently we received a complaint from a customer that a part of the frame of one of our shears had broken and the fractured section was forwarded to us. It was claimed by the purchaser of the shear that probably the iron was too high in silicon. We would like to know whether the casting was weak and if so, how can we increase the strength of the iron?

Answer.—The silicon in the fractured section forwarded to us is approximately three per cent. Up to three per cent silicon strengthens small castings such as hardware and stove sections. These castings cool so quickly that they would be exceedingly hard unless the silicon content were high. The grain of these castings is very close and the iron is consequently strong. Any brittle casting is strengthened by increasing the silicon content. Hardware and thin, ornamental castings are frequently made with iron containing as high as four per cent silicon. For heavy machinery, however, the reverse can be said to be true. The slow-cooling of a heavy casting converts the combined carbon into graphitic carbon and opens the grain. This action is more pronounced as the silicon is increased. A close grain is required to give strength to machinery castings. Close-grained pig iron should be used or a large proportion of machinery scrap should be charged. The silicon should be as low as possible to permit of the easy machining of the casting. The grain should be dark gray and very close. For such castings the silicon should not be above 2.25 per cent; sulphur, 0.075 per cent; phosphorus, 0.75 per cent, and manganese, 0.50 per cent.

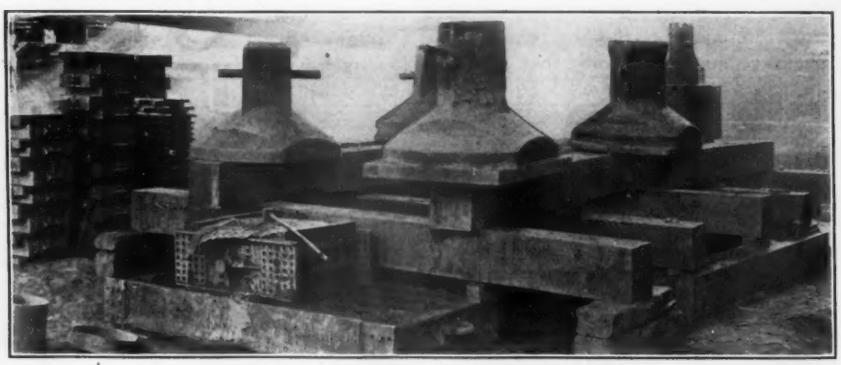


FIG. 10—METHOD OF WEIGHTING A LARGE CASTING

Babbitt Metals

We would like to have the formula for a babbit bearing metal.

There are so many different kinds of babbitt metals that it is difficult to know just what would be suitable in this case without more definite knowledge of the purpose for which the metal is to be used. A high grade babbitt can be made as follows: Tin, 93 pounds; copper, five pounds and antimony, 12 pounds. Melt the copper in a crucible furnace, and add the antimony gradually. The tin should have been melted at the same time in a babbitt kettle, and the molten alloy of copper and antimony is poured into the tin and thoroughly stirred. A cheaper alloy follows: Tin, 61½ pounds; lead, 25 pounds; copper, 3½ pounds, and antimony, 10 pounds. An excellent anti-friction metal contains lead, 85 pounds; tin, five pounds, and antimony, 15 pounds.

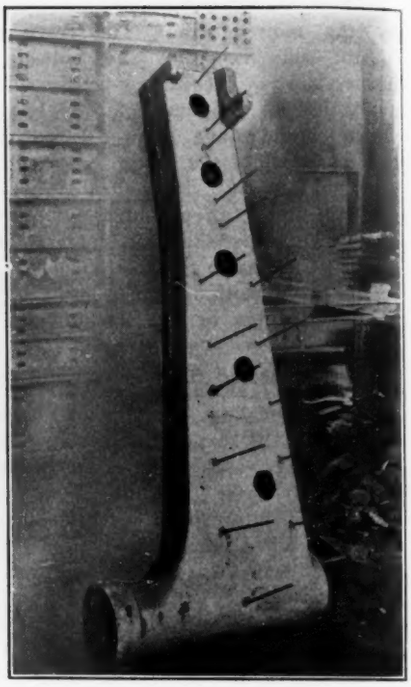


FIG. 11—RADIAL DRILL CASTING, SHOWING THE COPE SIDE

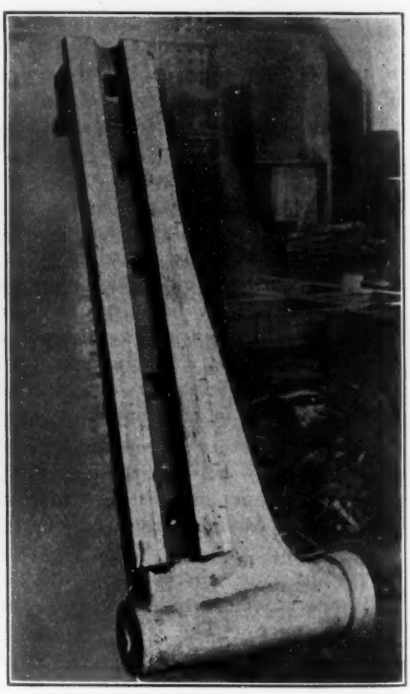


FIG. 12—DRAG SIDE OF RADIAL DRILL CASTING

PRODUCTION OF DIE-MOLDED CASTINGS*

Description of the machines for making these sections—The soft metals employed for this work

By Amasa Trowbridge

THE art of die casting, that is, the making of castings in steel molds to finished size and shape, was first introduced in connection with the manufacture of type. The first attempt at type founding was made in France, followed shortly by manufacturers in other countries. The first successful attempt in the United States was about 1735. As soon as it was established that finished type could be cast in steel molds, inventors naturally turned their attention to machines for doing the work. Such machines were attempted early in the nineteenth century and by the close of that century the perfected linotype and monotype machines, which are fine examples of die-casting machines, had been evolved. Machines for casting individual pieces of type are also still in use and the most recent ones

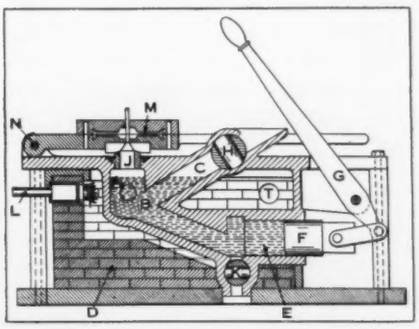


FIG. 1—MOLDING MACHINE WITH A MOLD LYING FLAT ON TOP

will cast about 125 to 150 pieces per minute. This gives some idea of the speed with which such castings can be made.

When the casting of type was perfected, it saved so much time that its usefulness for making other pieces which were wanted in large quantities was at once evident. Accordingly, many men have made efforts to perfect a machine or process by which they could turn out finished castings correct as to size and shape. Since type was first successfully cast it is natural that the same methods should be used for making other castings. So far no material superior to steel, the material used for type molds, has been found for making the matrices, or dies, as they are called. Brass can be and is used where the casting is very intermittent, as in a linotype machine, but for continuous work and where accuracy and truth are required, steel is necessary.

Metal for the Castings.

The next consideration after the material for the dies is that for the castings. Table 1 gives a few facts concerning the materials that are of interest in connection with this subject, whether for making dies or castings. There are only a few common metals with a melting point sufficiently low to be cast in steel dies, because these do not have to be brought to their melting point to be spoiled. If improperly treated in making, the dies are very susceptible to injury in use. Fine cracks are sometimes made in hardening the dies, causing them to break when subjected to the constant change of temperature which occurs in their use. Thin places in dies are more apt to get burned than heavy parts. For most work, hardened dies are superior to soft, but their cost is very much greater.

Making a Die Casting.

In general, the method of making a casting is as follows: A suitable die or mold is made in steel. This must be so arranged that when opened, the casting will either drop out or be easily ejected. The die should have the fewest possible partings. This is important because it is easier to hold the casting to correct size when the die is in a few pieces than when it is in many. Also, the fewer the partings, the fewer the fins that will be made on the castings.

Whenever cores are necessary, suitable means must be provided for withdrawing these without deforming the casting. The die must close properly, that is in correct alignment, and be held firmly, because the pressure of the fluid metal has to be overcome. The die being held closed in the machine, metal is forced into the die, pressure being provided by a pump which acts directly on the metal, by air pressure on top of the molten metal or by a head of molten metal. The metal is allowed only to set. The mold is then opened and the casting removed, the casting being left in the mold only as long as is absolutely necessary. If the die is too hot, it is then cooled and the operation repeated. The temperature of the die is important, and should be held constant because the expansion of the die will change the size of the casting. This operation is generally carried on in so-called hand-casting machines, that is, machines operated by manual labor.

Automatic machines are in use and have great advantages in producing uniform castings because the conditions do not vary. The automatic machine is run at a constant speed and is not subject to varying conditions due to the operator becoming

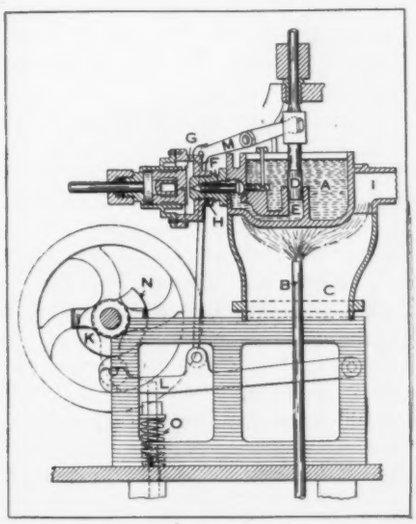


FIG. 2—AUTOMATIC MOLDING MACHINE

tired. Hand-casting machines produce quantities of 500 per day, more or less, depending on the size and complexity of the piece. Automatic machines produce the castings much more rapidly and save on labor just as does any other type of machinery.

While the writer has been able to find only one maker of casting machines who is willing to publish a description of them, a few illustrations are given to indicate the form of machine that is used, and it might be well to say that these actually show only the principles involved in each machine rather than the perfected mechanism.

Fig. 1 shows a machine in which

*Presented before the American Society of Mechanical Engineers.

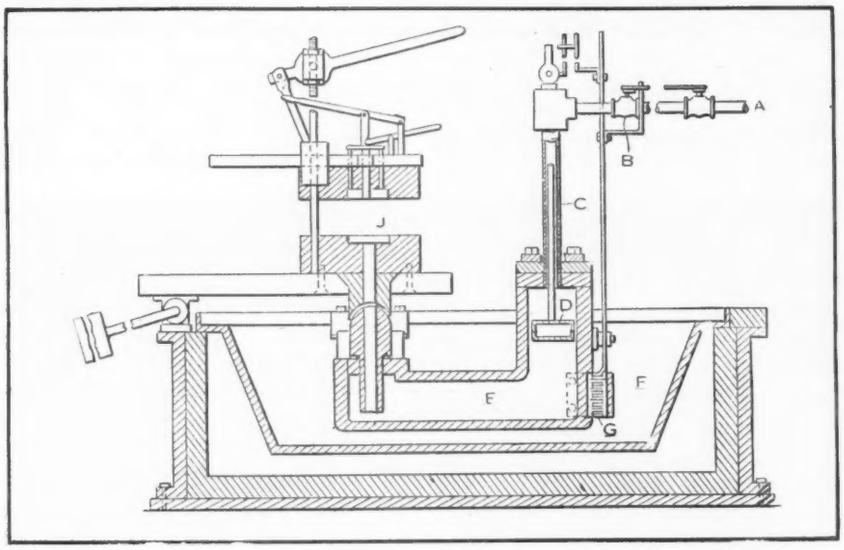


FIG. 3—TYPE OF MACHINE EMPLOYING AIR PRESSURE TO FILL THE MOLD

the metal is pumped into the mold by hand; *A* is the hot, molten metal; *C* the charging chute; *H* a valve to close this; *E* the pump cylinder; *F* the plunger; *G* the pump lever; *J* the nozzle through which metal is forced into the mold, *M*; *K* a valve for emptying the metal pot, *B*. The gas for heat is supplied through pipe, *L*, and the waste gases escape at *T*.

Fig. 2 shows an automatic machine. *A* is the molten metal; *B*, the gas pipe; *D*, the pump plunger; *E*, the pump cylinder; *F*, a valve to close the passage between the pump chamber and the metal pot, while metal is forced through the nozzle into the die or mold, *G*, which is brought up tightly against the nozzle while the metal is forced in. The left end of *F* closes the nozzle, while metal is drawn into the pump chamber by the raising of the plunger, *D*.

Fig. 3 shows a hand machine in which air pressure is used to force the metal into the mold. Air enters at *A* and is controlled by the valve, *B*. It comes down through the vertical pipe, *C* and exerts a pressure on the loose piston, *D*. This piston is hollow and floats on the metal contained in the pump chamber, *E*. Metal is admitted to this chamber, *E*, from the main metal pot, *F*, through the valve, *G*. The metal is forced by the pressure of the piston, *D*, out of the nozzle into the mold, *J*. The use of the piston, *D*, prevents oxidization of the metal from contact with the air which is admitted to force the metal into the mold. This air pressure is released before the valve, *G*, is opened so that metal can flow by gravity into the pump chamber. The metal which is forced directly into the mold is taken from below the top surface of the molten metal and this precludes the oxidized skin on top of the metal from being forced into the dies. Any of this oxidized metal would make bad castings, so that this point is important. The entire pump chamber in this arrangement is submerged in molten metal so that it is kept hot. The nozzle is so situated that it is probable extra means would have to be used to keep it heated and prevent the metal from freezing at this point. Undoubtedly, in the practical working out of the machine, this point was cared for.

Accuracy of Die Castings.

The feature about die castings which most appeals to the manufacturer is their accuracy. So long as the dies are in good condition, the castings should be perfectly true, both in size and shape. This does away with the necessity of gaging and makes it possible to use them without their having to be fitted into place by any hand work. A careful inspection is necessary, and this should be done as soon as possible after the castings are made so as to detect any flaws due to a slight failure of the dies. Any fins or burrs formed by the necessary joints in the dies can be removed at the same time that the castings are inspected. Usually these fins are not thick and can be taken off thoroughly and quickly with a light hand tool.

A difficulty due to shrinkage is sometimes encountered when these castings are to be used in connection with parts made by some other process. While the shrinkage will be the same in two castings made in the same die if the metal is properly handled, it does not always follow that it is proportionately the same when they are made from different molds. It is affected to a marked degree by the form of the casting, and if the castings are to be used in connection with machined pieces, it is advisable that these be machined to fit the casting. When it is not possible to do this and the casting must be fitted to existing pieces, sample castings should be made, and if these are not correct, the dies can be altered to make castings that are correct. In doing this, sufficient material must be allowed for grinding away, the casting being at first too small, although this makes a great deal of extra work.

Die Cast Cyclometer.

The greatest gain obtains when an entire machine can be made of such castings. One of the best examples of this is the Veeder cyclometer so universally used on bicycles. This instrument is composed of about a dozen die castings and nearly as many parts of other materials. The number rings have 0.001 inch play, and yet these castings are made in enormous lots and, without being gaged, are assembled into the die-cast cases where they fit and work properly. So exact are these castings that when new, the

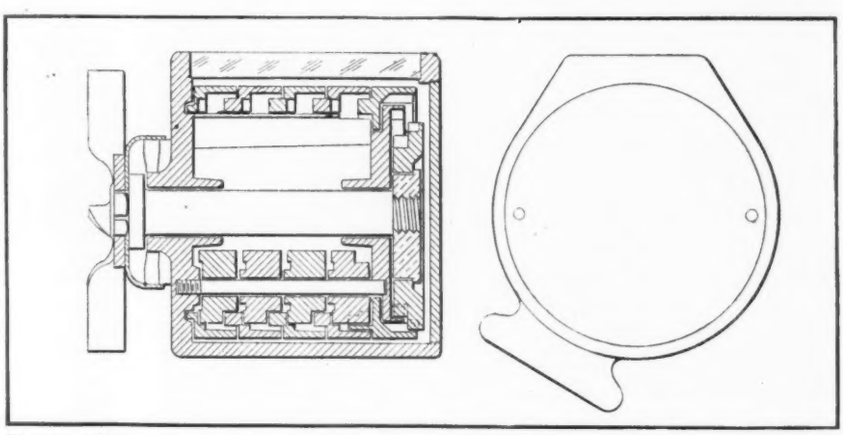


FIG. 4—VIEWS OF THE VEEDER CYCLOMETER, WHICH ALMOST ENTIRELY IS BUILT OF DIE CASTINGS

instruments work more easily without lubrication than with it. This would obviously be possible only where the clearances are extremely small. A small dimension on these castings can be maintained to 0.0001 inch. This instrument is illustrated in Fig. 4, the section view showing the rings both in their relation to the hub on which they turn and in contact with the transfer pinions. These latter turn on a German silver shaft 0.04 inch in diameter. The hub which forms the bearing for the number rings is so large in proportion to the width of these that they would tip and cramp if much end play were allowed. This makes it necessary to hold the dimensions on the rings correct within less than one-half of 0.001 inch.

Quality of Castings.

The quality of these castings depends on both the alloy used and the method of making them. The alloys in most common use are those having a zinc base. This metal is useful in certain alloys, particularly with copper, but if alloyed with aluminum is unsuitable for most purposes. Aluminum-zinc alloys are frequently used because aluminum makes the alloy lighter in weight and in color. Some time after manufacture, castings of this alloy begin to disintegrate and will actually fall to pieces. In the disintegrating process they also change shape badly so that they should never, under any circumstances, be used for pieces which are to stay flat or true. This alloy also tarnishes rapidly. Most of the alloys of zinc are too brittle to be of much use for the making of die castings. The usual effect of casting in metal molds is to make harder castings than would be made from the same metal in sand molds. For this reason a fairly ductile metal should be used.

The alloys of tin are being used quite extensively for die castings. These alloys possess the two desirable qualities of being quite ductile and of melting at a low temperature. Genuine babbitt metal, as it is commonly called, is an alloy consisting, according to the best authorities, of about 89 per cent tin, 7.3 per cent antimony and 3.7 per cent copper. This is a remarkably fine bearing metal and is possessed of sufficient strength to make it useful for many small parts. By certain changes in the alloy a composition even better for ordinary die-casting use can be produced.

The alloys of lead are used to a limited extent but, except for type, this metal is more often used in small proportions than as the foundation of the alloy. It is too heavy and lacks sufficient strength to make a very desirable metal. The percentage of lead in an alloy is sometimes increased for the sake of lowering the melting point and the price per pound.

Antimony is a common constituent of all die-cast alloys. The addition of this metal in the proper proportions, makes the alloy hard enough to machine well and increases the fluidity of the metal in its molten state. This makes it possible to obtain sharp castings such as are made from type metal, which is an alloy consisting of lead, 87½ per cent, and antimony, 12½ per cent.

In making an alloy of any two metals, when they are in correct proportions, there is formed an eutectic, the melting point of which is lower than that of either of the constituent metals. In some cases by the addition of a third metal, the melting point may be still further lowered.

The strength of die castings is, of course, largely dependent on the alloy, and also on the method of casting. Unless proper precautions are taken to insure sound castings, much trouble will be encountered from blow-holes. To prevent these is often very difficult and sometimes impossible. They are caused both by the form of casting and by the tendency of the molten metal to hold minute bubbles of air or other gases which are carried into the mold and do not escape before the casting sets. This is a case exactly parallel to that found in making iron castings. The shrinkage of the ordinary die casting is not as great as that of cast iron, and some of the tin alloys particularly shrink scarcely at all.

Another similarity to iron molding is found in the fact that the outside skin of the die casting is ordinarily stronger and harder than its interior. The hard outside skin is always desirable on a die casting, because the piece being cast to its finished size and no cutting being required, it is this outside skin which is first subjected to wear.

Exact figures on the strength of die castings might be quite misleading unless the exact composition and treatment of the castings were noted, so that general figures only can be given. They compare very favorably with cast iron in tensile strength, but are not nearly so strong in compression as that material. Their compressive strength is usually but little greater than the tensile, although it is somewhat, say one-third, greater. As the material is not as brittle as cast iron, it can be subjected to shocks which the iron would not withstand. Most die castings are much more ductile than cast iron. The greater ductility of the die castings is an advantage for threaded or tapped pieces. The castings do not chip out when tapped near an edge and a fine thread may be used. Some of the alloys are so ductile that the castings may be spun or riveted. This is often needed or is convenient for fastening two castings together or fastening a casting and some other piece.

Very little idea can be given of the cost of parts manufactured by the die-cast method. The tools or dies are costly or otherwise, according to their complexity or their simplicity. Practically all the die-casting manufacturers make the customer who ordered the castings pay for the dies. The parts are then charged for according to the time needed to cast them and the amount of metal used. As only the metal in the finished casting is charged for, there is no expense for scrap. The time for casting a complicated piece is little, if any, greater than for a simple one. From this it follows that the more complicated the casting, or the more difficult it would be to machine, the greater

DATA OF MATERIALS USED FOR DIES AND CASTINGS

Material.	Melting Point Deg. Cent.	Melting Point Deg. Fahr.	Strength, pounds, per square inch. Tensile.	Strength, pounds, per square inch. Compressive.	Modulus of Elasticity.
Aluminum	657	1,214	15,000	12,000	11,000,000
Antimony	630	1,166	.....		
Bismuth	266	511	6,400		
Cadmium	332	612	.....		
Copper	1,072	1,951	30,000		
Lead	326	618	2,000		
Magnesium	633	1,171	.....		
Tin	230	446	4,000		
Zinc	415	779	5,500		
Iron	1,505	2,742	52,000	85,000	28,000,000
Nickel	1,451	2,644	.....		
Steel	1,427	2,600	65,000	.....	33,000,000

will be the saving effected by the use of die castings. The number of pieces to be made from a die is also pertinent, for hundreds of thousands of pieces can be made from some dies with no injury whatever to them. Other dies may need frequent repairs due to unavoidably weak points in their construction. Number wheels having internal or hooded gear teeth are good examples of parts which are profitably made by this process.

A set of small number wheels and pinions will serve as a fair example for the comparison of costs by hand-casting machines and by automatic machines. The dies for this set of wheels and pinions for a hand machine would cost approximately $450. The number-wheel castings would cost, in lots of 1,000, about 10 cents each, and in lots of 10,000, about 8½ cents each. The pinion castings in lots of 1,000 would be 4 cents each and in lots of 10,000 would be 3 cents each. The cost of the dies for an automatic machine for the same wheels and pinions would be about $2,000. The number wheel castings in lots of 10,000 would cost about 2½ cents each, and in lots of 25,000 or more about 2 cents each. The pinion castings would cost about 1½ cents in 10,000 lots and in 25,000 or more lots, about 1 cent each.

The necessary die for a small internal and external gear would cost about $100 for a hand-casting machine, and the castings about 13 cents each in 10,000 lots. The dies for the same piece to be used in an automatic machine would cost about $450, and the castings would cost about 2 cents each in 10,000 lots, plus 8 to 9 cents each for metal.

Machine-Molded Automobile Castings*

By J. J. Wilson

NO LINE of work presents more interesting problems than are to be found in a foundry specializing in automobile castings. The proper selection of molding machines, the mounting of patterns and the necessary flask equipment are factors that must receive careful consideration. Our experience with molding machines dates back a little less than five years and has been quite satisfactory. Today we are producing work which, at that time, we hardly thought possible could be made on a machine and it is believed to be but a question of the right kind of machine equipment to produce much more difficult work than has so far been attempted. There are four distinct types of molding machines: Squeezer, stripping plate, rock-over and jarring; other machines are combinations of the foregoing types.

Experiences With Molding Machines.

The experiences of some foundrymen, with molding machines, have been disappointing. This is undoubtedly due to the insufficient care exercised in the selection of the proper type of machine for the work. Each type of machine is especially adapted for a certain class of work, but no one type of machine is suitable for all kinds of work. One of the first questions asked by a foundryman when buying a molding machine is whether new patterns will be required. This question is usually answered in the negative. The foundryman is assured that his patterns can be used, or that pattern plates can be cheaply made of aluminum or some other material of a similar nature. This is where the second serious mistake is made. If you are going to install molding machines in your foundry, start right; make the selection of machines with care and have the best pattern equipment obtainable; iron flasks, well-made wood or metal snap flasks, with parts interchangeable, should be installed. All pin holes should be drilled accurately with a jig which has been fitted with hardened steel bushings. Then camp on the job until the first piece of work is a success before starting another; if there is a sufficient number of castings to make, the results will fully justify the expenditure. Heretofore we have employed molders who could make castings with very little supervision; today we have the untrained workman who must be developed into a molding machine operator.

The superintendent, foreman or instructor must furnish the experience for the operator until he becomes proficient. The instructor must teach him how to do the work and should stay with him until he can do the work alone before being left to himself. Supervision for a considerable time will be necessary.

In the operation of molding machines, the following suggestions should be kept in mind:

First.—Never close a machine-made mold which must be patched. If a mold is not properly made it should be shaken-out.

Second.—Let the operator understand that if the mold is not perfect it cannot be poured. A pieceworker will quickly profit by this suggestion.

Third.—If a pattern does not draw perfectly have it repaired immediately. The time saved with a perfect pattern means more and better molds.

Fourth.—Remember that patience is required to make a good machine operator and the new man usually lacks confidence in himself. However, when he becomes master of the machine the making of molds is usually a pleasure.

Fifth.—Machine molders must be recruited from the ranks of the laborers; they should be trained until they become skilled parts of the machine.

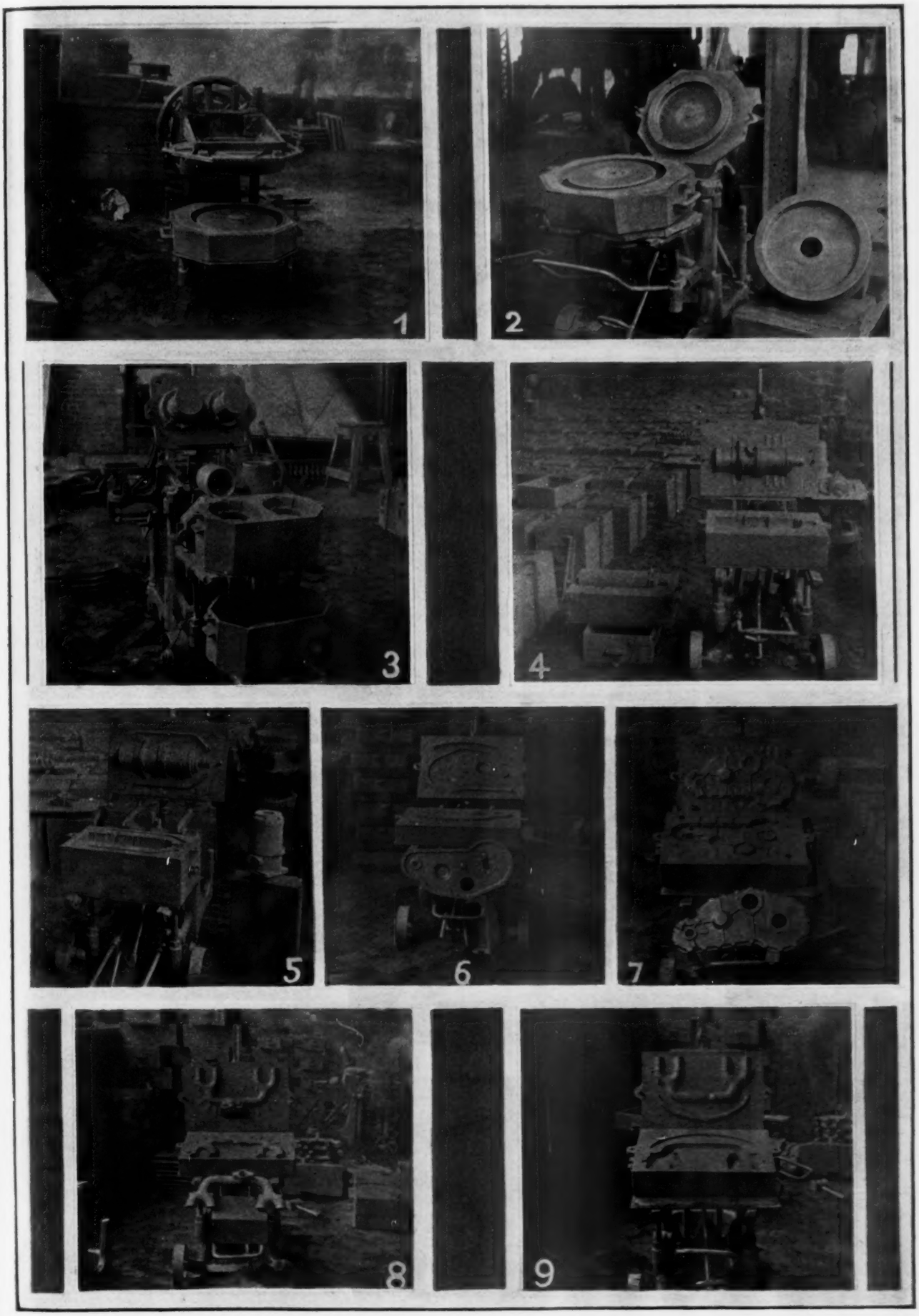
Automobile Work.

Some of the automobile work made on molding machines with unskilled labor by the Cadillac Motor Car Co., Detroit, and the Michigan Motor Casting Co., Flint, Mich., is shown in the accompanying illustrations. In Fig. 1 is shown a web fly-wheel which is made on a Grimes roll-over molding machine. The mold is lowered away from the pattern plate by the large hand wheel at the back. This type of machine has been recently improved by the addition of a carriage on which the mold is deposited before it is placed on the floor. In Fig. 2 is shown the cope half of the fly-wheel mold, which is made on a rock-over molding machine, built by Henry E. Pridmore, Chicago. The pattern plate is rolled back and at the right is one of the finished fly-wheels. While fly-wheels are usually considered very simple castings they are not as easily made as would seem to be the case. These castings are finished all over. A row of very small gates is shown near the center of the cope half. This method of gating insures clean castings.

Machine-Molded Pistons.

In Fig. 3 is shown the drag half of a mold containing two pistons. The patterns are mounted on a rock-over molding machine which has a deep draw. The cope is plain and is rammed on a stand. The method of gating is interesting, six gates being provided in each piston mold. The leaders in the cope nearly surround the entire mold. The drag half of a mold for a Cadillac motor car cylinder, made on a rock-over molding

*Presented at the New York meeting of the National Founders' Association.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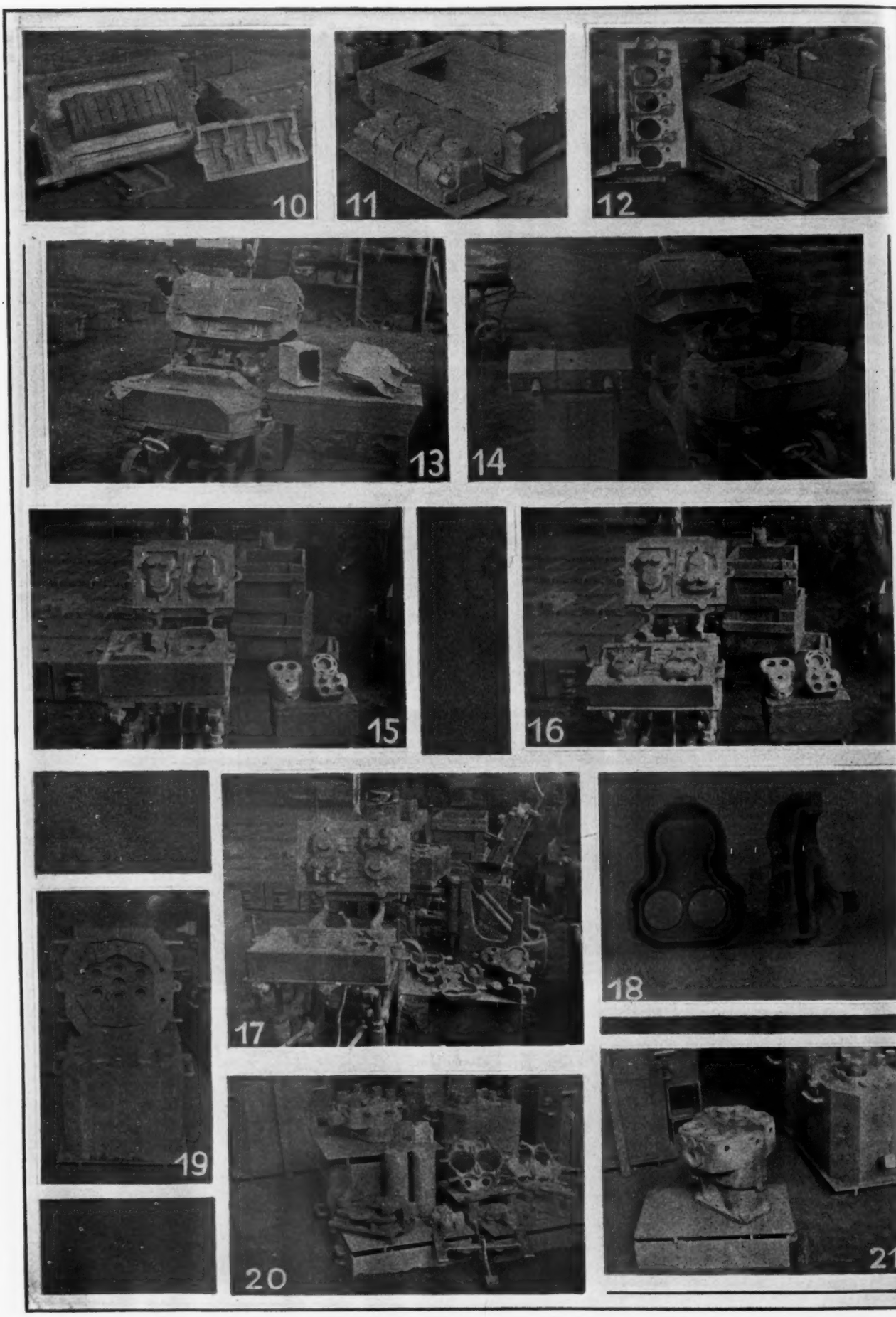
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machine, is shown in Fig. 4. The pattern has just been drawn from the mold. At the left, resting on a flask, is shown a drag with the cylinder core in place. The method of gating is interesting, as it has been especially devised to uniformly distribute the iron so as to prevent segregation in the heavy sections. The cope half of the cylinder mold is shown in Fig. 5 and a finished casting is on a box at the right.

An engine end plate, mounted on a rock-over molding machine, is illustrated in Fig. 6. This shows the drag half of the mold and a casting, drag side, is also illustrated. The cope half of the engine end plate, which is also molded on a rock-over molding machine, is illustrated in Fig. 7. The casting, showing the cope side, is resting against the lower part of the molding machine. The flask is 13 x 21 inches and the casting is exceedingly thin. The distribution of the gates on both sides of the cope, which is more clearly illustrated on the pattern plate, is interesting. All corners of the gates have been carefully rounded, thus avoiding sharp points in the mold which are so readily broken off. Intake pipes are also being molded on machines of the roll-over type. The drag half of an intake pipe mold, with a finished casting and the pattern plate in an elevated position, are illustrated in Fig. 8. The method of gating is clearly indicated. In Fig. 9 is shown the cope half of the same mold. It will be noted that a generous runner is provided. These castings are very thin and must be as smooth inside as outside. This intake pipe connects the carburetor with the combustion chambers on the engine.

Crank Case.

The cope and drag of a mold which forms the oil pan or the bottom half of the crank case, are shown in Fig. 10; a finished casting is shown in the foreground. Six cores are set in the cope, a gage being used to locate them carefully in their proper positions. The casting is only 3-16 inch thick. The drag half of the mold, which forms the upper half of the crank case, is illustrated in Fig. 11. At the left is shown the machine-made mold with the core in position, while at the right the core has not yet been set. The core for this mold is shown in the foreground. The core is 26 inches long, 10 inches high and 10 inches wide and is satisfactorily set and located by laborers. The crank case casting is illustrated in Fig. 12.

Lubricator bodies are molded on machines of the roll-over type, two being mounted on one plate, as illustrated in Fig. 13. This is the cope half of the mold and also shows two finished castings on the table at the right. The cope half of a lubricator body mold is molded as indicated in Fig. 14 and at the left is shown the core which is ready to be set. These castings are exceedingly thin and are tested with gasoline to detect leaks. The method of molding combustion chambers is illustrated in Figs. 15, 16 and 17, while Fig. 18 shows two castings cut through different sections to indicate the uniformity of the metal thicknesses. These molds are made on a rock-over machine, the cope and drag halves of the pattern being mounted on one plate. In Fig. 16 the cores have been set and a gage for locating them is also shown. The various parts of the combustion chamber core are illustrated in Fig. 17. These parts are all carefully pasted and wired together.

Water-Cooled Cylinders.

Twin, water-cooled cylinders are now made on rock-over molding machines in the two foundries whose work is being described, and in Fig. 19 are illustrated the cope and drag halves of the mold just before the cores are set. Fig. 20 shows various parts of the cylinder core as well as one of these cores assembled on a plate at the left. The barrel cores are located by a gage. These cores are very difficult to set in a green sand mold without shaving or scraping the sides; if this occurs the casting will be defective. In the foreground, Fig. 21, is shown one of the twin-cylinder castings.

The judicious use of the molding machine will insure the following results:

A greater output per man and per pattern.

Castings will be more uniform and true to pattern. This is essential for automobile or other castings upon which jigs and special tools are used for all the machine operations.

The product is made at a reduced cost.

Quality does not apply alone to the foundry making automobile castings, but applies equally as well to all casting plants. It is easy to make poor rough, dirty castings, and it is hard but fascinating work to make good ones. Our aim has been not to secure a large output from the machine, thereby sacrificing quality, but as large a day's work as is consistent with quality. Perfection should be the standard in every department, from the drawing to the cleaning room, each detail requiring careful study.

The designer should endeavor to eliminate sharp angles, corners and irregular pockets without fillets, and in the general design of the part he must bear in mind that it is to be manufactured and not made. In the jobbing foundry, castings are made, but in the specialty foundry castings are manufactured.

Suggestions for the Patternmaker.

Before making a new model, the patternmaker should consult with the foundryman with a view to avoiding all loose pattern parts. Loose pieces are always liable to be rammed out of place and when they do form a part of a pattern some mechanical contrivance should be provided for drawing them out of the mold; they should never be pinned onto the body part of the pattern. The multiplicity of loose pieces on a pattern makes it comparatively easy to misplace bosses and other parts which are not an integral part of the main body pattern. It is essential that patternmakers familiarize themselves with foundry work. A realization of the importance of the proper amount of draft on patterns is essential to the proper manufacture of castings.

The inspection of cores should receive considerable care. It is only by closely watching the product that cores made from boxes which are worn can be detected. If the cores are not properly inspected, it frequently occurs that many of them are made in boxes from which a piece may have been lost, or the boxes may be badly worn, or the sand is not properly rammed and the cores are made with the corners or edges broken off. Such cores are unfit for use.

Shop conditions, to a large extent, affect the quality of the work of the molders and coremakers. If we expect the men to do their best we must furnish them with a cool foundry in summer, which should be warm and well-ventilated in winter and above all with the best of equipment. The equipment, including patterns, molding machines, flasks, small tools, etc., should be the best obtainable to insure the production of castings of high quality.

When gating a casting, considerable experimenting will frequently be required. Occasionally, in some foundries, a casting will be run with one or two gates when a dozen or 15 might be used to advantage. The iron in the mold should be so distributed that the danger from segre-

(*Continued on page 169.*)

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Contents

Large Cast Steel Ladles..... 131
Comparative Foundry Cost Records 133
Peculiar Properties of Pig Iron.... 137
Casting Brass Oil Cups on Steel Straps 140
Renovating Molding Sand..... 140
A Large Foundry for Light Castings 141
Latter-Day Pattern Shop Methods—V 148
Molding Heavy Fly-Wheels..... 150
Casting Bronze Screen Plates..... 153
Deoxidizers for Copper Alloys..... 154
Crucible Difficulties 156
Anti-Acid Metals 156
Use of Copper Scrap..... 156
Universal Pattern Board for Split Patterns 157
Thin, Detached Skin on Malleable Castings 158
Strength and Silicon..... 160
Production of Die-Molded Castings. 161
Machine-Molded Automobile Castings 164
Trade Outlook 168
Alloyed Steel in 1910..... 169
Foundry Exhibition Co.'s Meeting.. 169
August Marx, Death of..... 169
Personal 169
Large Jar-Ramming Machine..... 170
Largest Shockless Molding Machine 170
New Method of Coring-Out Castings 171
Using a Small Cupola..... 171
Annealing Equipment in Malleable Foundries 172
Trade Notes 173
Trade Publications 173

Trade Outlook

Improved trade conditions in the steel industry are already being reflected in the foundry business and orders for steel and malleable castings for the large number of cars recently purchased by the railroads, are already being placed. For the first time in more than a year the great Homestead plant of the Carnegie Steel Co., near Pittsburgh, is operating at capacity and steel car shops throughout the country have resumed operations in full. It is estimated that during the past few weeks orders for 40,000 steel cars have been placed and contracts for 60,000 additional will undoubtedly be closed before the first of the year. It is estimated that for the cars already placed and in prospect, approximately 800,000 tons of castings will be required and many shops will again resume operations in full when all of the casting orders for these cars have been closed. In addition, the railroads are placing large contracts for rails and there is every indication of a general resumption of railroad buying. It is also gratifying to note that pig iron stocks at all of the blast furnaces throughout the country are gradually declining, which indicates that consumption is ahead of production. Low prices, however, continue to prevail on foundry grades and sales have been made at lower lake ports at prices ranging from $13 to $13.75 for various deliveries. Notwithstanding these low values, foundrymen generally are not availing themselves of the opportunity to close for future requirements, although prices practically represent cost of production. Foundries specializing in automobile work are operating at capacity and the plants of practically all of the builders of motor cars are employing a full complement of men. In the various large consuming centers No. 2 foundry iron is quoted as follows: Pittsburgh, $14; Chicago, local, $14, and southern, $14.35; Cleveland, $13 to $13.25; Cincinnati, northern, $14.20; Philadelphia, plain, $14.50; New York, plain, $14.50, and southern, Birmingham, Ala., $10.

One Volume a Year

This issue of THE FOUNDRY completes Vol. 39, which comprises four issues, beginning September, 1911. The index for this volume will be found on the last pages of this number. Volume 40 of THE FOUNDRY will begin with the January issue, 1912, and will consist of the 12 numbers published during that year. Heretofore, the 12 numbers of THE FOUNDRY have been divided into two volumes, but it is believed that the new arrangement will be more advantageous for reference purposes and will also effect economies in binding.

Referring to the article describing the continuous foundry of French & Hecht, Davenport, Ia., published in THE FOUNDRY, November, 1911, we are advised by J. L. Hecht, that it was an error to state that the new foundry was designed and built under his supervision. Emil Einfeldt did this work and is entitled to the credit.

Alloyed Steel in 1910

From statistics compiled by the American Iron and Steel Association and recently published, the tonnage of steel treated with various alloys during 1910 reached a total of 567,819 gross tons. The tremendous growth of the use of alloys is indicated by the fact that in 1909 the total alloyed steel produced was only 181,980 tons. The total tonnage of ingots and castings for the various forms of alloyed steels as distributed among the steel-making processes, follows: Titanium, 326,316; nickel, 106,707; nickel-chrome, 52,021; chrome, 23,550; manganese, 19,360; vanadium, 9,049, and other alloys, 30,816 gross tons. It was reported to the association that alloyed steel ingots and castings were made in 66 plants in 17 states and the District of Columbia in 1910.

Geo. E. Lees, of the Vanadium Co. of America, Pittsburgh, questions the correctness of the total vanadium steel tonnage given by the American Iron and Steel Association, whose reports are always very carefully compiled from complete returns from steel manufacturers. A communication on this subject from Mr. Lees is, in part, as follows:

"The total production of vanadium steel in 1910 reported by the American Iron and Steel Association as 9,049 tons, I am confident is incorrect, as I have written to the principal manufacturers of vanadium steel and have their replies showing that the production of vanadium steel in the United States for 1910 was approximately 40,000 tons. I have exact statements from 21 manufacturers; several refused to disclose their figures. This total of 40,000 tons includes only vanadium steel and not the large amount of vanadium used in the manufacture of iron castings and a smaller quantity used in brass, bronze, white metal and bearing metals. In *Engineering*, May,

1911, a contributor estimates that the annual consumption of metallic vanadium in the United States is 250,000 pounds, and that it is used at the rate of five pounds per ton of steel. On this basis the production of finished vanadium steel would have been 50,000 tons."

Universal Board For Split Patterns

(*Continued from page 167.*)

gation in the heavy sections will be overcome. The pattern equipment should be inspected and if patterns do not match up properly they should be immediately returned to the pattern shop for repairs.

In melting our iron it has been our policy to make very small charges which are uniformly distributed. All of the iron, coke and limestone are carefully weighed. No special effort is made to save fuel at the expense of an inferior product. The quality of the iron is our only consideration, regardless of whether we melt at the ratio of 1 to 5 or 1 to 9. The cleaning room of every foundry is an exceedingly important department. It costs money to machine hard, dirty, rough castings. Such castings are dear at any price. While it is true that castings may not be any better, they certainly appear 50 per cent better after being well ground, tumbled and sand-blasted and the cost of machining will be considerably reduced.

The cleaning room inspector also plays an important part in the operation of a foundry. Very few employes are qualified to properly inspect castings. In few shops are the inspectors given ample instructions relative to the defects which should lead to the rejection of castings. Our inspectors are instructed to pass castings that are good and to throw out all defective work. We draw an arbitrary line between good and defective castings.

The leather fillet manufactured by the Page Belting Co., Concord, N. H., is soft and flexible and has a fine feather edge. This fillet can be easily and perfectly adapted to any curve or radius of a pattern. The feather edge enables the patternmaker to fit the fillet accurately in its place. This fillet is made in full length strips and is carried in stock in the seven branch houses of the Page Belting Co., located respectively at Boston, New York, Philadelphia, Chicago, St. Louis, Chattanooga, Tenn., and Portland, Ore.

Foundry Exhibition Co.'s Meeting

The annual meeting of the Foundry & Machine Exhibition Co. was held at the Fort Pitt hotel, Pittsburgh, Monday, Oct. 30. The recommendation of the directors, made at the meeting in Buffalo, regarding the dividend to be paid exhibitors was endorsed. It was decided to pay a 20 per cent dividend on the amount paid for space at the Pittsburgh show to concerns which had taken part in two consecutive exhibits, and for those who exhibited at Pittsburgh for the first time the dividend will be held in reserve and will be paid if they take part in the Buffalo exhibit. At a meeting of the stockholders, directors were elected as follows: R. S. Buch, A. Buch's Sons Co., Elizabethtown, Pa.; J. W. Campbell, Cleveland Wire Spring Co., Cleveland, and E. A.

H. R. ATWATER, PRESIDENT OF THE FOUNDRY AND MACHINE EXHIBITION CO.

Pridmore, International Molding Machine Co., Chicago. Geo. R. Rayner, Carborundum Co., Niagara Falls, N. Y., was elected a director to fill a vacancy on the board. The board of directors organized by electing H. R. Atwater, Osborn Mfg. Co., Cleveland, president; R. S. Buch, vice president; J. S. McCormick, J. S. McCormick Co., Pittsburgh, treasurer, and C. E. Hoyt, Lewis Institute, Chicago, secretary. F. N. Perkins, Arcade Mfg. Co., Freeport, Ill., R. S. Buch and Geo. B. Rayner constitute the executive committee.

At a meeting of the directors held in Buffalo, Sept. 15, for the purpose of completing plans for the 1912 exhibit, it developed that the Sixty-ninth arsenal, which had been offered for exhibition purposes in 1912, would not be available, as contemplated alterations would not be completed in sufficient time for the show. An effort was then made to secure, if possible, the Sixty-fifth regiment building, but concessions for this structure could not be obtained. It was announced at Pittsburgh that the Seventy-fourth armory could be leased and the executive committee was instructed to visit Buffalo for the purpose of investigating the facilities afforded by this structure.

August Marx

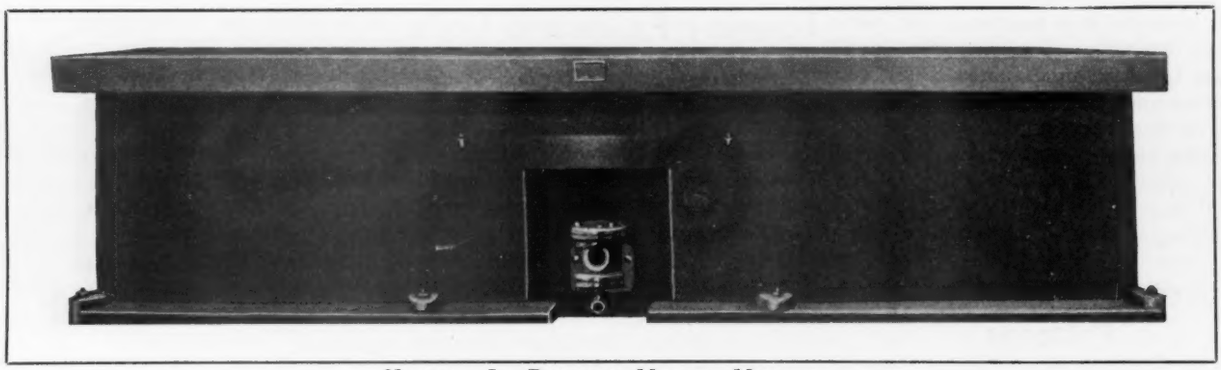
August Marx, general manager of the Philadelphia Roll & Machine Co., Philadelphia, died at his home in that city, Nov. 6. Born at Bad Homburg, Germany, in 1857, Mr. Marx left home at the age of 13, taking passage on a sailing vessel as a cabin boy. After three years of this service he went to Philadelphia, where he finally took up his residence. In 1880, Mr. Marx obtained employment with the Lombard & South Street Passenger Railway Co., and he was later advanced to the position of superintendent of the Passyunk division of that system. In 1891 he resigned his position and in 1892 became affiliated with the William Wharton Jr. & Co., Inc., and was appointed superintendent of materials for the construction of the Third Avenue Railroad Co., New York City. At the time of the formation, in 1895, of the Philadelphia Roll & Machine Co., a subsidiary of the Wharton company, Mr. Marx severed his connection with the parent concern and assumed the active management of the new company. He is survived by his widow, a daughter and a son.

Personal

W. T. Nicholson Jr. has resigned his position as salesman with the J. W. Paxson Co., Philadelphia. Mr. Nicholson was directly connected with the eastern branch of this company at Providence, R. I.

Geo. S. Capes, formerly connected with the Nathan Mfg. Co., New York City, has accepted a position with the Lima Locomotive Co., Lima, O., where he is serving as one of the works executives.

Henry T. Russell, president of the Niagara Purchasing Agents' Association for the past two years, has resigned as purchasing agent of the Lumen Bearing Co., Buffalo, and has accepted a position with the sales department of the same concern. Albert Lockwood has been appointed to the position formerly held by Mr. Russell.



HERMAN, JAR-RAMMING MOLDING MACHINE

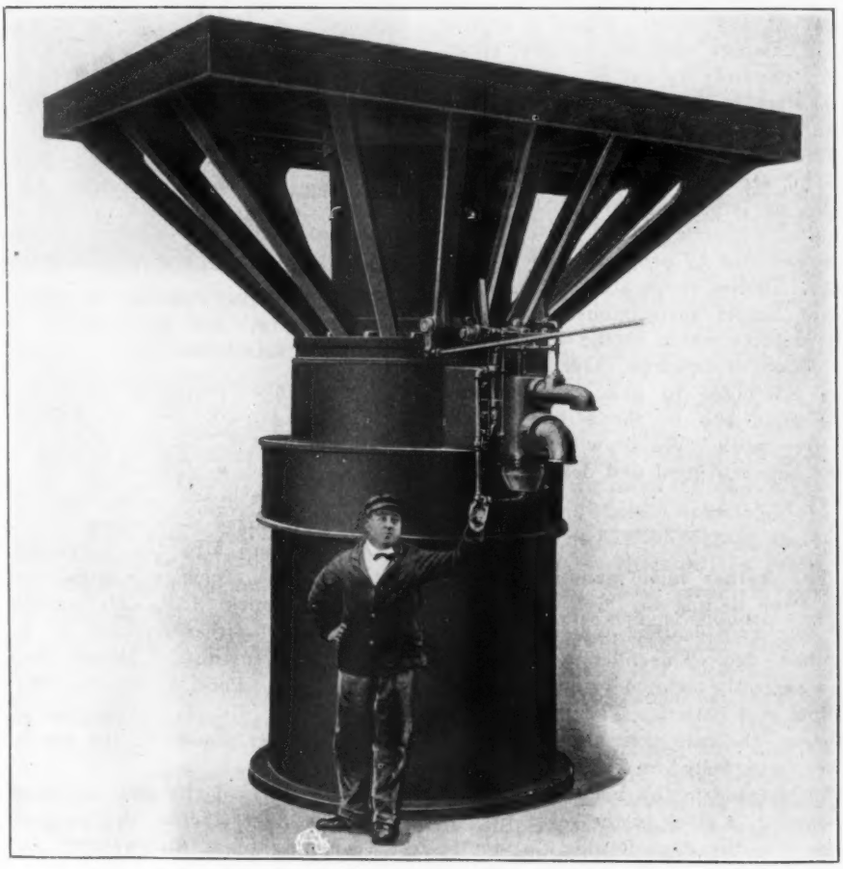
Large Jar-Ramming Machine

The jar-ramming molding machine, shown in the accompanying illustration, built by the Herman Pneumatic Machine Co., Zelienople, Pa., is equipped with a table, 4 x 12 feet, and has a capacity for lifting 25,000 pounds at an air pressure of 80 pounds. The machine consists essentially of a cast steel table plate, plunger, cast iron base and an automatic control valve. To prevent the table plate from tilting as a result of unbalanced loads and also to relieve the stress that would otherwise be thrown upon the plunger, eight wearing plates of ample length and width are employed. The plates serve as guides and are lubricated by reservoirs containing packing waste and oil, located in the table plate. Oil for the cylinder is delivered by a pipe to a groove which extends around the cylinder interior. This method of oiling is practically dustproof. The table plate is provided with an apron which partly envelops the base, thereby protecting the interior of the machine from the sand.

The machine is controlled by an automatic differential valve which is operated by air that would be otherwise wasted. The port from the valve to the cylinder is short and being straight, there is no loss of efficiency by short turns or choked passages. The movable part of the valve has a travel of 3-16 inch and as it is automatic, the air consumption is limited to the amount required to lift the load a certain number of blows a minute. The automatic and positive action of this valve prevents injury to the machine as a result of careless operation. The valve consists of a top and bottom head, double check valve stem, differential piston and the body. All operating parts are inside of the body, and the only openings consist of the inlet, the port to the cylinder and the exhaust to the atmosphere. The seats of the valve are so arranged that the valve may be reground a number of times. This machine has been especially designed for long flasks and by the use of I-beams clamped on the table plate, flasks having a length of 25 feet can be satisfactorily rammed. Two machines of this size are now in operation in foundries in the Pittsburgh district.

Largest Shockless Molding Machine

What is believed to be the largest jar-ramming molding machine ever built and which is the largest of the shockless type yet manufactured, is shown in the accompanying illustration. This machine was built by the Tabor Mfg. Co., Philadelphia, and is equipped with a steel table, 8 x 12 feet, with cylinder attached, 36 inches in diameter. It is mounted upon a plunger base of cast iron, weighing about 65,000 pounds. The plunger base is fitted in the cylinder base, five feet in diameter and rests upon 22 helical steel springs, aggregating over 3,000 pounds in weight. The total weight of the machine, as shown, is between 90,000 and 100,000 pounds. The machine has already been tested and will soon be shipped to a large iron foundry in the vicinity of Philadel-

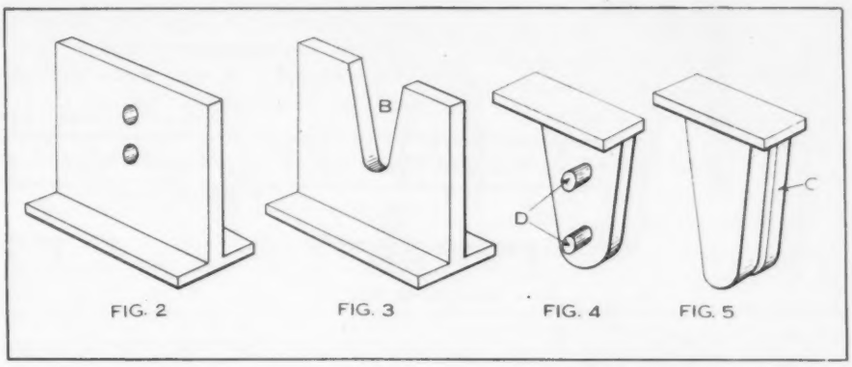


TABOR SHOCKLESS JARRING MACHINE, EQUIPPED WITH A TABLE, 8 x 12 FEET; THE CYLINDER IS 36 INCHES IN DIAMETER

New Method of Coring-Out Castings

A new method of coring-out castings, by means of which it is claimed the use of a flask consisting of three or more parts may often be obviated, has been perfected by G. E. Anderson, South Bend, Ind. The general features of the method, which is patented, are shown in the accompanying illustrations. The pattern is cut away at the points where it is to be cored and dry sand cores are used in place of a portion of the pattern in forming the mold.

In carrying out the method a two-part flask is used, consisting of an ordinary cope and drag, Fig. 1. The casting which has been selected for the purposes of description is shown in Fig. 2. It consists of a T-section with two holes cored through the web as indicated. The pattern, Fig. 3, is made to conform to the general outline of the casting, but is provided with an open end, tapered slot, *B*. A core print, Fig. 5, is made to fit in this slot. It is provided with a tapered body portion which accurately fits the aperture in the pattern and with an enlarged section, *C*, Fig. 5, designed to rest against the side of the pattern, thus preventing lateral displacement of the print while ramming the mold. The core which is used in forming the mold is shown in Fig. 4. It is provided with two small projections, *D*, which make the holes through the web of the casting.



THE CASTING WITH THE HOLES CORED IN THE WEB IS SHOWN IN FIG. 2; FIG. 3 IS THE PATTERN WITH THE SLOT FOR THE CORE PRINT; FIG. 4 IS THE CORE AND FIG. 5, THE CORE PRINT

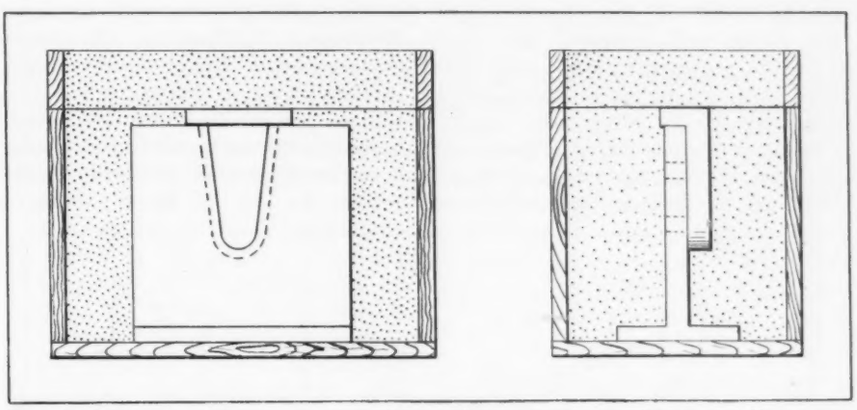


FIG. 1—SECTIONAL VIEWS OF THE DRAG CONTAINING THE PATTERN WITH THE CORE IN PLACE

The pattern is placed on the roll-over board in the usual manner and the core print, Fig. 5, is mounted with its body portion filling up the slot and its side flush with the side of the pattern. The sand is then rammed around the pattern and the core print, leaving the upper side of the base of the print exposed, as indicated in Fig. 1. The print is then withdrawn and the core, Fig. 4, inserted in its place. The drag flask is then completely filled with sand, rammed and rolled over. The core is held firmly in its proper position in relation to the mold by the sand after the pattern is withdrawn.

This method of molding can be applied to a large variety of castings of different shapes. The core is set and remains in a fixed position prior to the removal of the pattern; this lessens the danger of breaking down the mold, which is liable to occur when the core is set after the pattern has been withdrawn. This is especially true in the case of deep, narrow molds in which it is difficult to place a core after the removal of the pattern without breaking some part of the mold. Furthermore, it is not necessary in using this method of molding, to split the pattern at each point where a hole is to be cored through the casting. By the use of a single core, applied in the manner described, properly enlarged, several apertures, it is claimed, may be formed in a single casting and located at any part of the mold.

Using a Small Cupola

By W. J. Keep

Question:—We have never successfully operated a small cupola, although we use a mixture which gives us soft iron when melted in our large cupola. When this same mixture is tapped from the small cupola the iron is exceedingly hard.

Answer:—We have used a cupola lined to 16 inches which will melt 500 pounds of iron and sometimes even a larger amount before the blast has to be shut-off and we are now using a cupola, 21 inches inside diameter, which will melt 1½ tons satisfactorily. At times, we have melted as high as 3 tons in the latter cupola. The expense of operating a small cupola consists of the cost of frequent repairs to the lining and the cost of breaking the pig iron into small pieces so that it can be easily charged. A frequent cause of difficulty in the operation of small cupolas is due to the fact that these furnaces are not operated with the same care as cupolas of larger capacities and frequently the furnaces are not well designed. Regardless of the size of the cupola, the tuyeres should always be at least 10 inches from the sand bottom; the slag hole should be at least 6 inches from the bottom and the slag should be tapped as soon as possible. In a small cupola the proportionate tuyere area should be greater by one-half than the proportion for a large cupola and this area should be divided over at least six tuyeres. It is advisable not to locate a tuyere directly over the slag hole, as the blast will chill the slag. A small cupola should be heated for a longer period than a large furnace and never less than two hours. The same proportion and amount of limestone should, however, be used. The blast pressure should not exceed 6 or 7 ounces, while a

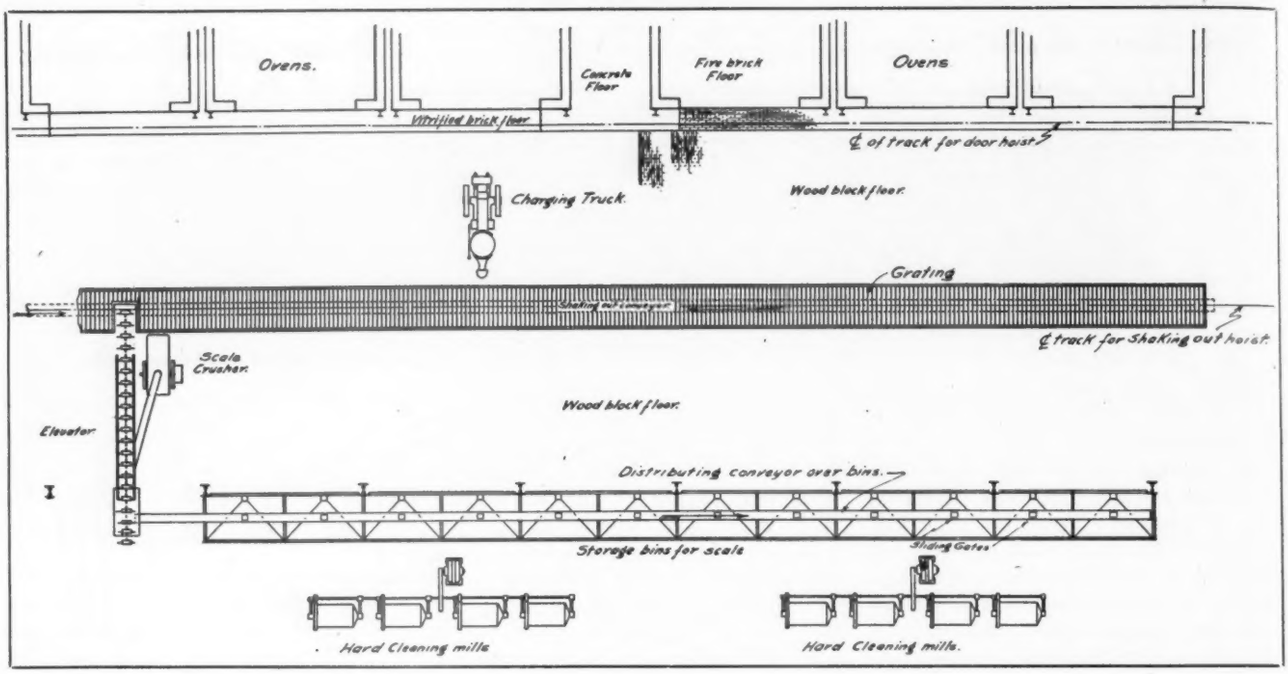


FIG. 1—PLAN VIEW OF ANNEALING DEPARTMENT, SHOWING OVENS, GRATINGS AND CONVEYOR, ELEVATOR AND SCALE DISTRIBUTOR

cupola 60 inches inside diameter, will take from 14 to 18 ounces. The small cupola will not melt as successfully as a large furnace. A cupola 16 inches in diameter will melt 3 pounds of iron per pound of coke and a 21-inch cupola, 5 pounds of iron per pound of coke; the melting ratio of a 60-inch cupola will easily be 9 to 1. It might be advisable to slightly increase the silicon for the mixture melted in the small cupola and great care should be exercised in charging. If you use all sprues from your large cupola you can melt faster and with less coke in the smaller furnace.

Annealing Equipment in Malleable Foundries

By Geo. K. Hooper.

The magnitude of operations in malleable iron foundries necessitates the installation of various mechanical handling devices. An inviting opportunity for development, and one which has brought profitable returns, is found in the handling of the stacks of pots with the castings and scale for the annealing operations. The possibilities in a plant making bulky castings and producing several thousand a day are shown in the accompanying illustrations. This plant has been in operation for about a year and a half, a sufficient period to prove its satisfactory and economical operation. It will be noted that the hard cleaning mills are so located that the cleaned castings may be placed upon a bench where, after snagging, they can be loaded directly into the pots, the storage bins for scale being directly over this bench. The soft cleaning barrels are in another room adjacent to the finishing department The ample space in front of the furnaces has proved a great benefit.

In considering the development of these mechanical handling devices we must begin, historically, with the replacing of the old hand truck or fork for filling and emptying the oven, with the power-charging truck. The first type of power-charging truck, was operated by compressed air, necessitating a complicated arrangement of hose, which required laborers for handling. Following the compressed air machine there were introduced, almost simultaneously, the steam truck, with its own steam generator, and an electrically-operated device in which electricity was substituted for compressed air. The steam machine replaced practically all types, although its design is far from satisfactory, because of insufficient boiler capacity. However, this machine has changed a laborious and uncomfortable task into a comparatively easy duty and at the same time has effected great economies. Incidentally, the power-charging truck has made it possible through increase in size of the oven to take advantage of the greater efficiency obtainable with liquid, gaseous or pulverized fuel, which also permit the use of larger ovens, in

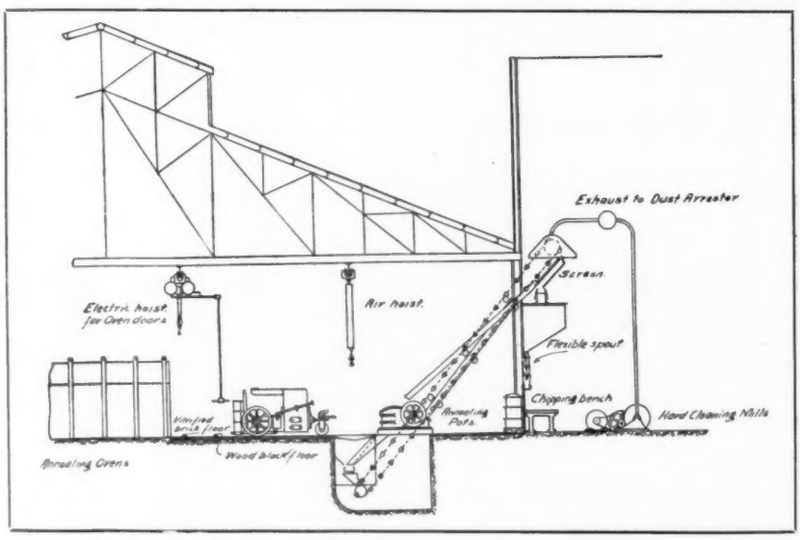


FIG. 2—END ELEVATION OF ANNEALING DEPARTMENT SHOWN IN FIG. 1

keeping with the larger production of the modern foundry.

Referring to Fig. 1, it will be noted that the floor upon which these machines operate is of great importance, the loads being heavy and the vehicle self-propelled, conditions which cause much slippage of the rough treads of cast wheels, which, in turn, is hard on the floors ordinarily used. A prime necessity is a concrete foundation with a wearing surface of hardwood blocks on end. From an extended trial this type of floor appears to be satisfactory. For greater durability, an insulating strip of vitrified paving brick is laid along the front of the ovens and is covered with iron plates during the period in which the ovens are being loaded and discharged.

Handling the Scale.

The mechanical handling of scale has always been a serious problem. The scale is hot, lumpy, dusty and very severe upon any apparatus used for handling. One of the early mechanical methods of separating the scale from the shaken-out castings was to dump the entire mass—castings and scale—into a large tumbling mill with openings between the side bars. It was supposed that the scale would drop through these openings, leaving the castings fairly clean, but inevitably lumps of scale would not break up in such a mill and much of it passed out with the castings, which required subsequent separation and handling. The cost of carrying the whole product to one place and the return of a heavy load of pots, bottoms, etc., did not prove economical, and the handling of the whole of the lumpy scale was likewise expensive.

The best method for shaking-out the scale is to provide a grating with a conveyor underneath for receiving the scale, which delivers it to a suitable place for screening, crushing and the removal of the dust. To support the loads and to withstand the shocks caused by the dropping of pots filled with scale, the grating must be heavy and well-supported. The conveyor under the grating must withstand severe service in loading and changes of temperature. Its driving apparatus must be isolated.

When the scale has been delivered to the point for screening and for the removal of dust, it will be fairly cool, but the work of elevating and screening requires a construction with parts of ample size. The removal of dust greatly increases the quality of the scale because it consists principally of inert material of no value in the annealing process.

Apparatus of considerable power is essential for crushing the lumpy scale which may be conveyed from the screening operation direct to the crushers, which in turn discharge into the conveying system.

Overhead Bins.

From the crusher the conveyor distributes the scale to overhead bins from which it is discharged through flexible spouts into the annealing pots. The scale and castings are then thoroughly settled in the pot. This simple method is quite as efficient as a complicated jarring device.

Another recent development is the application of liquid, gaseous or pulverized fuel to reduce the time of annealing operation. This is accomplished by reducing the time of raising the oven with its charge up to annealing or soaking temperature. The choice of fuel depends largely upon local conditions. Pulverized coal, when carefully ground to proper size, is economical and satisfactory. The length of the oven is important in this connection, and an oven 45 feet long can be handled safely.

Heavy Sand Shipments

The large fleet of vessels, consisting of more than 30 barges and steamers operated by the Whitehead Bros. Co., Providence, R. I., is now engaged in the delivery of sand to various foundries throughout the east for the winter requirements of these shops. In addition, the Whitehead Bros. Co. reports that its tonnage of sand shipped from its mines by rail even exceeds its heavy shipments by wafer. This company also reports a heaxy export demand and, in addition, is a large importer of sand for special foundry purposes.

Pittsburgh Foremen's Association

At a meeting of the Pittsburgh Foremen's Association, held Friday, Oct. 20, Robert B. Thomson, secretary of the Buffalo Foundry Foremen's Association and president of the Associated Foundry Foremen, presented the Pittsburgh foremen with a handsomely-carved lignum-vitae gavel. This gavel is modeled after the butt and pean of a rammer with a small flask between these sections to hold the handle. On either side of the pean are engraved silver plates. This gavel was presented by the Associated Foundry Foremen to the Pittsburgh society in commemoration of the reception given by the latter to the foundry foremen in attendance at the foundrymen's meeting on May 22, 1911.

Trade Notes

The H. W. Johns-Manville Co., New York City, has removed its Birmingham, Ala., office from 1220 Empire building to 606 Chamber of Commerce building. This office is under the management of W. H. Fleming.

The American Blower Co., Detroit, will erect a plant in Canada on a site of 4½ acres on the Essex Terminal railway, at Windsor, Ont. An erecting shop will be built, 50 x 200 feet, of steel and concrete construction. A foundry will also be added, work on which will be commenced in the spring. The Canadian Sirocco Co. will manufacture a full line of the American Blower Co.'s products, consisting of fans, blowers, heating, ventilating and drying apparatus, steam engines, steam traps, etc.

The Johnston Harvester Co., Batavia, N. Y., has recently completed the installation of steel pattern storage racks which is believed to be the most extensive of its kind ever made. This equipment, which consists of 72 units, 360 feet long, was built and installed by the Berger Mfg. Co., Canton, O. Each unit is 40 inches deep, 60 inches wide and 11 feet, 6 inches high and has a shelf area of 200 square feet and the total area of the entire system is 14,400 square feet. The shelves are capable of carrying a load of 250 pounds, making the total capacity for each unit 3,000 pounds. In addition to these steel pattern racks, the Berger Mfg. Co. has furnished the Johnston Harvester Co. with 35 hoppers and 18 core oven doors.

Trade Publications

SIFTING MACHINES.—A 36-page catalog, issued by the Hanna Engineering Works, Chicago, is devoted largely to this company's extensive line of riddles and screen shakers. These include pneumatic tripod shakers, stationary post shakers, trough shakers, electric riddle oscillator, revolving dumping riddles and accessories. A portable mold dryer is also illustrated, as well as the Hanna line of riveters. The catalog also contains a partial list of users of these sifting machines.

FURNACES.—In a handsomely illustrated 32-page catalog, Tate, Jones & Co., Inc., Pittsburgh, illustrate and describe their extensive line of heating, forging and welding furnaces. The work includes descriptions of oil or gas-fired tool dressing furnaces,

blacksmith forges, portable and stationary rivet forges, pipe bending furnaces, bolt heating furnaces, forge furnaces, flue welding and rod heating furnaces, etc. Interesting plan and sectional views are also included of an oil or gas-fired tire heating furnace. Burners, appliances and accessories are also described, as well as a portable fuel oil heater. The catalog also contains interesting information on furnace efficiency.

DUPLEX STEAM-DRIVEN COMPRESSORS.—A 20-page bulletin, published by the Ingersoll-Rand Co., 11 Broadway, New York City, is devoted to duplex steam-driven compressors. These machines are of rigid construction with large bearing surfaces and are equipped with mechanically-actuated air intake valves with large direct passages and cushioned discharge valves. The air cylinders have water-jacketed barrels and heads, the latter being hooded for the admission of cool air. The smaller types of compressors up to 15-inch stroke have overhung cylinders. On the larger sizes the air cylinders are supported on a strong foot-piece resting upon a sole-plate on the foundation.

FIRE BRICK FOR CUPOLA LININGS.—A 30-page booklet, issued by the Harbison-Walker Refractories Co., Pittsburgh, is devoted to this company's extensive line of fire brick and shapes for cupola linings. In addition to views and dimensions of the various shapes, the booklet contains a brief story of the manufacture of this foundry material. Interesting records of cupola operations with Harbison-Walker linings show an average daily melt for one furnace of 61,656 pounds for a period of 231 days or a total melt of 5,714 tons. This cupola was 72 inches in diameter. Another cupola with a similar lining, 78 inches in diameter, was operated 231 days, the melt having totaled 5,927 tons or an average of 51,316 pounds daily. Interesting suggestions are included regarding the use of fire brick and silica brick and the work concludes with tables of circle brick, arch brick and 9-inch key brick.

General Industrial Notes

The Shull Steel Castings & Mfg. Co., Canton, O., will change its firm name to the Canton Steel Foundry Co., on Dec. 31, 1911.

The H. L. E. Peterson Mfg. Co., Elgin, Ill., has been incorporated with a capital of $25,000 to engage in the foundry business. The incorporators are H. L. E. Peterson, Albert Fehrman and Julius G. Peterson.

The Craig Foundry Co., Bucyrus, O., which recently took over the Bucyrus Foundry Co., has placed the plant in operation. The company will make a specialty of hot air registers and radiators.

The General Foundry Co., Warren, O., has completed its new foundry for the manufacture of steel castings. The main building is 140 x 300 feet and a pattern building, core shop, etc., have also been erected.

Hess, Snyder & Co., Massillon, O., manufacturers of stoves, ranges, furnaces, pumps, etc., are completing an addition to their foundry, 80 x 120 feet, and have installed a dust arrester in their cleaning department.

The Precision Lubricator & Mfg. Co., Chicago, has been incorporated with a capital of $21,000 and will erect and equip a brass and iron foundry and a machine shop. The incorporators are John S. Roberts, Emerson B. Stoddard and C. M. Adams.

The American Foundry & Supply Co., Asheville, N. C., has moved into its new quarters on Avery street. The new plant comprises a foundry, 60 x 80 feet; pattern shop, 40 x 80 feet; machine shop building, 40 x 105 feet, and a mill supply building, 40 x 90 feet.

The American Ship Windlass Co., manufacturer of stokers and marine equipment, has abandoned its Providence, R. I., plant and all of the business of this concern is now transacted at Philadelphia where a large plant is operated. A large foundry was recently added to these works.

The Waynesboro Metal & Foundry Co., Waynesboro, Pa., has been incorporated with a capital of $50,000 to engage in the manufacture of iron, steel and brass castings. The incorporators are F. D. Miller, C. V. Moore, Geo. H. Armacast and John C. Benedict of Westminster, Md., and Geo. D. Beaver, of Waynesboro, Pa.

The Hunsicker Engineering Co., Lebanon, Pa., has been incorporated with a capital of $50,000 and will engage in the foundry and machinery business. The company will occupy the plant formerly operated by the Treadwell Engineering Co. The officers of the new company are Harry H. Boger, president; R. H. Rhodes, vice president; John Hunsicker Sr., treasurer, and John Hunsicker Jr., secretary.

The Scullin-Gallagher Iron & Steel Co., St. Louis, manufacturer of open-hearth steel castings, has recently installed three cranes of 30, 10 and 5 tons capacity, which were built by the Alliance Machine Co., Alliance, O., and two cranes of 25 and 10 tons capacity furnished by the Niles-Bement-Pond Co., New York City. This equipment, with the six new mold-drying ovens, new core room and five core ovens and the extensions to the main foundry, annex and chipping shops of the No. 2 plant, will more than double the steel casting output of the Scullin-Gallagher Iron & Steel Co. The No. 1 plant of this company was doubled in capacity less than a year ago. Three traveling cranes, 18 jib cranes and an air compressor with a capacity of 5,500 cubic feet of free air per minute were installed. This plant will operate exclusively on steel castings for railroad work.

New Construction.

The Union Spring & Mfg. Co., New Kensington, Pa., is erecting an addition to its foundry, 40 x 60 feet.

The Illinois Malleable Iron Co., Chicago, is contemplating the erection of a foundry on North Paulina street.

The Valley Gray Iron Foundry, Saginaw, Mich., is erecting a two-story addition to its plant, 33 x 92 feet.

The Central Foundry Co., Oklahoma City, Okla., is contemplating the erection of an addition to its foundry, 70 x 150 feet.

The Liberty Foundry Co., St. Louis, is erecting an addition to its foundry, 65 x 101 feet.

The Campbell, Wyant, Cannon Foundry Co., Muskegon Heights, Mich., will erect an addition to its foundry, 65 x 196 feet.

The Goodale Co., 508 North Church street, Kalamazoo, Mich., contemplates the erection of a foundry, 150 x 210 feet, of brick construction.

Beauchemin & Fils, Ltd., Sorel, Que., are erecting a large addition to their foundry, 80 x 100 feet. The equipment will include a converter of 2½ tons capacity.

The board of education, Huntington Park, Cal., will erect a manual training addition to the Union high school. The building will include a forge shop, pattern shop, foundry, machine shop and drafting room.

The National Iron Foundry & Supply Co., Williamsport, Pa., is establishing a branch foundry at Oneida, N. Y., which will be known as the Oneida Foundry Co. The company is in the market for a cupola, elevator, fan and casting cleaning machinery.

The American Dartuim Castings Co., St. Joseph, Mo., has been incorporated with a capital of $150,000 and will equip a plant for the manufacture of steel castings. The incorporators are Edward Richard, John Thompson and Eugene W. Colville.

The Maclean Foundry Co., Upper Sandusky, O., has been incorporated with a capital of $80,000 and will erect a foundry, 240 x 20 feet. The incorporators are R. J. Main, A. B. Whitney, B. H. Van Blon, Chas. Shealy, Richard Carter, Edward F. Stephan, L. H. Hull, Earl Carter and Ira V. Maclean.

The Chicago Steel Foundry Co., Nineteenth and Rockwell streets, Chicago, has purchased a 226 x 298-foot site on the Chicago & Alton railroad, between Thirty-seventh street, Thirty-seventh place and Kedzie avenue. A foundry, 150 x 200 feet, will be erected, in addition to a pattern shop and office building.

The Munson Bros. Co., Utica, N. Y., manufacturer of iron castings, contemplates the erection of the following buildings at Whitesboro, N. Y.: Foundry, 100 x 200 feet; pattern shop, 50 x 160 feet, and a warehouse and shipping building, 50 x 300 feet. The plant will be of steel frame construction with concrete foundations and brick walls.

Kling Bros. Engineering Works, Chicago, recently incorporated with a capital of $250,000, have plans prepared for the erection of a large plant, including a machine shop, 162 x 250 feet and a foundry, 150 x 250 feet. This concern will engage in the manufacture of iron, steel and brass castings and will install a 30-ton electric traveling crane in both the machine shop and foundry, in addition to other foundry equipment. Several other buildings will also be erected, including a pattern shop, boiler shop, power house, etc.

Among the Brass Founders.

J. T. McCormick, San Francisco, Cal., is erecting a brass foundry, 35 x 100 feet.

The Aluminum Castings Co., Detroit, is erecting an addition to its foundry on Campau avenue.

The Waterbury Brass Co., Waterbury, Conn., is contemplating the erection of a new casting shop.

The Imperial Brass Mfg. Co., Chicago, is erecting a six-story plant, 100 x 125 feet. A brass foundry will be installed, which will be equipped with Fisher oil furnaces.

The Elyria Brass, Iron & Steel Co., Elyria, O., has been incorporated with a capital of $50,000 to engage in the manufacture of brass, iron and steel castings. The incorporators are J. V. Kennedy, T. J. Whearty, David M. Ryan and others.

Index to Volume XXXIX

September---December, 1911

A

Alloy, A Strong..... 147
Alloy, Bearing 76
Alloying Nickel and Copper..... 18
Alloys, Copper, Deoxidizers for..... 154
Alloys of Brass and Bronze..... 74
Alloys, Heusler, Magnetic Properties of.. 75
Alloys, New Aluminum..... 75
Aluminum Bronze, Corrosion of 16
Aluminum Bronze, Difficulties of Casting. 109
Aluminum in Iron..... 36
Aluminum, New Method of Annealing.... 73
Aluminum Rolled and Cast Steel..... 37
Anderson, G. E., Description of New Method of Coring Out Castings..... 171
Annealing Equipment in Malleable Foundries 172
Annealing Steel Castings 7
Apprentices, Practical Course for..... 45
Arcade Mfg. Co., Description of Molding Machines 82
Arcade Mfg. Co., Description of Motor-Driven Sand Sifter..... 126
Atherium, Properties of..... 27

B

Bench, Portable Molder's..... 84
Bins, Sectional Steel..... 42
Bins, Steel, for Pattern Storage and Foundry Use 84
Boiling Points of Metals..... 12
Book Reviews:—
Annual Statistical Report for 1910..... 39
Hendrick's Commercial Register..... 124
Industrial Plants, Their Arrangement and Construction 39
Life and Life Work of Chas. B. Dudley 39
Principles of Scientific Management.... 81
Boron Flux for Copper Castings..... 69
Boron, Instructions for Use of in Copper 69
Brass, Alloys of 74
Brassfounding, Railroad 110
Brass Foundry Products, Corrosion of.... 15
Brass, Melting of, in Japan..... 30
Brazing Metal 19
Brick, Chrome, Data Sheet No. 102, November, 1911.
British Foundrymen's Convention 32
Bronze, Alloys of..... 74
Bronze, Aluminum, Difficulties of Casting. 109
Bronze Castings, Methods of Gating..... 13
Bronze Screen Plates, Methods of Casting 153

C

Cannon Balls, Casting, in the Eighteenth Century 58
Carbon Control in Cast Iron..... 25
Carbon in Cast Iron..... 34
Cards, Uniform Laboratory Report..... 86
Cast Iron Art Work..... 28
Cast Irons for Foundry Purposes..... 33
Cast Iron, Shrinkage of..... 104
Casting, A Large Bronze..... 128
Castings, Coring-Out, New Method of.... 17
Castings, Die-Molded, Metal Mixtures for. 161
Castings, Die-Molded, Method of Production 161
Castings, Machine-Molded Automobile ... 164
Casting Large Plates in Open Molds..... 30
Casting-On, Brass Cups on Steel Straps.. 140
Casting Rolls for Paper Machines..... 24
Castings, Brass, Honeycombed..... 18
Castings, Bronze, Methods of Gating..... 13
Castings, Cleaning for Plating..... 147
Castings, Dip for Copper, Data Sheet No. 101, November, 1911.
Castings, Growth of Crystals in..... 35
Castings Influence of Heating on..... 140
Castings, Malleable, Thin, Detached Skin on 158
Castings, Steel, Made by Converter Process 9
Castings, Warping of 34
Chain Sprockets 54
Chart, Showing Comparative Cost of Castings 134
Chill Casting Alloy..... 19
Chilled Castings from Non-Chilling Iron.. 60
Chromium Bronze, Data Sheet No. 97, September, 1911.
Cleveland Wire Spring Co., Description of Steel Bins 84
Coatings for Steel Cores, Data Sheet No. 98, September, 1911.
Cold and Hot Blast Iron Compared..... 33
Comparative Foundry Cost Records..... 133
Comstock-Wellman Bronze Co., Description of Foundry..... 70
Continuous Molding Table..... 63
Convention of British Foundrymen..... 32
Converter, An Oil-Fired Steel..... 67
Converter, Bretaud 83
Converter Process for Small Steel Castings 9
Copper Alloys, Vanadium in..... 17
Copper, Melting of, in Electric Furnace.. 73
Core Boxes, Large..... 52
Core Conveyor 10
Core Machine, A Jar-Ramming..... 42
Coremaking Process, A Continuous..... 10
Cores for Globe Valves..... 53
Cores, Wax Vents for, Data Sheet No. 98, September, 1911.
Coring-Out Castings, New Method of.... 171
Cost Records, Comparative Foundry..... 133
Crucible Difficulties 156
Crystals, Growth of, in Castings..... 35
Cupola and Crucible Furnace Combined.. 108
Cupola, Method of Using a Small..... 171
Cupola for Semi-Steel..... 128
Cupola, How it Was Cured of a Severe Attack of Indigestion..... 103
Cupola Melting Difficulties..... 55
Cupola, Method of Slagging..... 27
Cups, Brass, Casting-On on Steel Straps. 140
Cylinder Mixtures, Gray Iron..... 129

D

Defective Casting Report Sheet..... 133
Deoxidizers for Copper Alloys..... 154
Deoxidizing Elements for Use in Copper and Its Alloys, Data Sheet No. 97, September, 1911.
Dip, Bright, For Brass, Bronze, Copper and German Silver, Data Sheet No. 101, November, 1911.
Dip for Copper Castings, Data Sheet No. 101, November, 1911.
Dip for Removing Sand from Brass Castings...Data Sheet No. 101, November, 1911
Dust Exhaust Systems for the Foundry... 1

E

Editorial:—
Accident Prevention in Foundries..... 38
Air Blast for Cupolas..... 122
Modern Foundry Practice..... 80
Women in Core Rooms..... 122
Electricity, Application of, in Foundries. 61
Electroplating 39
Exhaust Systems for Foundry Dust..... 1

F

Facing Mixture for Skin Dried Molds, Data Sheet No. 98, September, 1911.
Flask, An Improved Sectional..... 87
Flask Equipment 54
Fly Wheels, Molding Heavy..... 150
Formulas for Finding the Weights of Iron Castings, Data Sheets No. 99 and 100, October, 1911.
Foundry, A Japanese Pipe..... 60
Foundry, Brass, A Well-Equipped Jobbing 70
Foundry Cost Records..... 133
Foundry Dust Exhaust Systems 1
Foundry, Gray Iron, A Continuous..... 115
Foundry and Machine Exhibition Co., Annual Meeting of 169
Foundry, Steel, Description of..... 89
French & Hecht, Davenport, Ia., Description of Gray Iron Foundry..... 115
Furnace, Crucible, and Cupola Combined.. 108
Furnace, Crucible, With Air-Cooled Bottom 114
Furnace, Electric, Melting of Copper in.. 73
Furnace, Open-Hearth, Hearth Area of... 6
Furnaces, Oil-Fired Open-Hearth 5
Furnaces, Open-Hearth Tilting 89

G

Galvanizing, New Method of..... 104
Gating Bronze Castings, Methods of..... 13
General Industrial Notes.....44, 88, 98, 174
Gray Iron Foundry for Light Castings, Description of 141
Grinder, Motor-Driven, Swinging Emery Wheel 86
Grinder, Portable 127

H

Hanna Engineering Works, Description of Riddle Oscillator 86
Herman Pneumatic Machine Co., Description of Large Jar-Ramming Molding Machine 170
Hood, Exhaust, Applied to Emery Wheels 1
Hood, Exhaust, Applied to Tumbling Barrels 1

I

International Harvester Co.'s Springfield, O., Foundry, Description of..... 141
Iron, Cast, Carbon Control in..... 25
Iron, Cast, Silicon in, Relation of Strength to 160
Iron, Non-Chilling, Chilled Castings from 60
Iron Phosphide, Cause of Shot Formation 36
Iron, Protective Lead Coatings for..... 79
Iron, Soft, for Pole Shoes..... 152
Iron, Spongy, How to Overcome..... 152
Iron, Strong 3

K

Kreutzberg, L. J., Description of Improved Sectional Flask 87

L

Ladles, Molding Large Cast Steel..... 131
Lewis Institute, Work of..... 46

M

Machine, Jar-Ramming, Use of Timbers as Table Extensions..... 81
Machine, Jarring, Murphy Duplex..... 87
Machine Molding, Combination Squeezer and Jar-Ramming..... 82
Machine, Molding, Development of..... 49
Machine, Molding, Drop Plate with Squeezer Attachment 79
Machine, Molding, Large Jar-Ramming.... 170
Machine, Molding, Largest Shockless.... 170
Machinery, Motor-Driven, in Foundries.. 61
Malleable Castings, Production of..... 11
Malleable Castings, Thin, Detached Skin on 158
Malleable Foundries, Description of Annealing Equipment in 172
Malleable Iron, System in Annealing.... 65
Malleable Works, A Well-Designed..... 105
Match-Plate, Development of..... 20
Melting Points of Metals; Data Sheet No. 104, December, 1911.
Merritt & Co., Description of Steel Shelving for Pattern Storage..... 126
Metallography as an Aid to the Iron Founder 35
Metal Mixtures:—
Aluminum 75
Anti-Acid 156
Anti-Friction 27
Bearing 76

Bell 113
Bidery 114
Brass 74
Brass, Soft Yellow 76
Brazing Metal 19
Brittania 114
Bronze 74
Bronze for Bushings 15
Bronze, Nickel 76
Chrome Bronze . . . . . —
Ingots Made from Scrap 110
Nickel Bronze 76
Phosphor-Bronze for Bearings 19
Phosphor-Tin 113
Solder for Aluminum 79
Speculum 76
Trolley Wheels 113
Valve Bodies 113
Valve, Low Cost 76
White, for Beatings 112
Metals, Bearing, Effect of Repeated Melting of 114
Metals, Microscopic Examination of 35
Microscopic Examination of Metals 35
Mold for Chilled Rolls 77
Molding Air-Cooled Cylinders 43
Molding Bushings for Steam Cylinders . . . 60
Molding Cast Steel Slag Ladles 131
Molding Machine, Development of 49
Molding Machine, Rock-Over Stripping Plate 40
Molding Machines, Multiple 23
Molding Machine, Stripping Plate 40
Monthly Comparative Cost Report of Castings 135

N

National Brake & Electric Co., Description of Steel Foundry 89
National Roll & Foundry Co., New Chilled Roll Making Process 77
Nickel and Copper Alloys 18
Noyes Scholarships 48

O

Obituary:—
Dwyer, James 124
Foley, James E 124
Gobeille, Joseph Leon 123
Hillman Sr., J. H 124
Kelly, Thomas P 123
Marx, August 169
McLaren, John 124
Vannier, Chas. H. 124
Oil, Fuel, Use of, in Steel Foundries . . . 81
Open-Hearth Furnace, Hearth Area of . . 6
Osborn Mfg. Co., Description of Drop Plate Molding Machine with Squeezer Attachment 79
Oscillator, A New Riddle 86

P

Pattern Board, Universal, for Split Patterns 157
Pattern Shop Practice, Latter-Day—II . . . 21
Pattern Shop Practice, Latter-Day—III . . 51
Pattern Shop Practice, Latter-Day—IV . . 99
Pattern Shop Practice, Latter-Day—V . . . 148
Personal 39, 81, 123, 169
Pickle for Cleaning Brass Castings, Data Sheet No. 101, November, 1911.
Pig Iron, Peculiar Properties of 137
Pig Iron, Relation of Chemical Analyses to Physical Tests 137
Pittsburgh Foremen's Association 173
Pittsburgh Steel Foundry, Description of Swinging Emery Wheel Grinder 96
Plates, Bronze Screen, Methods of Casting 153
Pole Shoes, Soft Iron for 152
Portage Silica Co., Sand Blast Sand Supply 85
Prescott Malleable Iron Co., Description of Plant 105
Production of Malleable Castings 11

R

Railway System, Industrial, for Foundry. 56
Ransom Mfg. Co., Description of Portable Grinder 127
Refractories for Foundry Use; Data Sheet No. 102, November, 1911.
Renovating Molding Sand 140
Rolls, Crusher, Gray Iron Mixture for . . 128

S

Sand Blast Sand 85
Sand Mixing Machine Co., Description of Portable Molder's Bench 84
Sand, Rational Analysis of 31
Sand Sifter, A Motor-Driven 126
Sand Sifter, A Portable Rotary 31
Scrap Copper, Use of 156
Scrap, Use of Stove Plate 102
Semi-Steel, Cupola for 128
Shelving, Steel, for Pattern Storage 126
Shrinkage Difficulties 55
Sifter, Portable Rotary Sand 31
Silicon in Cast Iron, Relation of Strength to 160
Silvery Iron, Use of 58
Skimmings, Brass, Utilization of 18
Slag Ladles, Large Cast Steel 131
Smith, J. D., Foundry Supply Co., Description of Sand Blast Tumbling Barrel. 125
Solder, Spelter, Corrosion of 75
Specific Gravities of Metals; Data Sheet No. 104, December, 1911.
Steel, Addition of, to Iron 27
Steel, Alloyed, in 1910 168
Steel Castings, Heat Treatment of 36
Steel Castings, Methods of Annealing 7
Steel Castings, Small, by Converter Process 9
Stock Oil-Fired Converter 67
Strong Iron 3

T

Tabor Mfg. Co., Philadelphia, Description of Largest Shockless Molding Machine. 170
Tin Analysis; Data Sheet No. 103, December, 1911.
Trade Notes 87, 127, 173
Trade Outlook 38, 80, 122, 168
Trade Publications 44, 88, 129, 173
Transportation of Material in Foundries. 56
Tumbling Barrel, Sand Blast 125

V

Valves, Globe, Cores for 53
Vanadium in Copper Alloys 17

W

Weights of Metals; Data Sheet No. 104, December, 1911.
Wentworth Institute, Description of Foundry Course 78
Wheels, Polishing, Equipped with Exhaust Hoods 1

Author's Index, Volume XXXIX

A

Andres, G. E., Comparative Foundry Cost Records 133

B

Bagnall, W. F., Art as Expressed in Cast Iron 28
Brassiere, A. L., Difficulties of Casting Aluminum Bronze 109
Buchanan, R., Carbon Control in Cast Iron 25

D

Dwyer, Pat, How the Cupola Was Cured of a Severe Attack of Indigestion 103

E

Estep, H. Cole, A Modern Wisconsin Steel Foundry 89

G

Giele, W. S., Latter-Day Pattern Shop Practice—II 53
Giele, W. S., Latter-Day Pattern Shop Practice—III 51
Giele, W. S., Latter-Day Pattern Shop Practice—IV 99
Giele, W. S., Latter-Day Pattern Shop Practice—V 148

H

Hooper, Geo. K., Annealing Equipment in Malleable Foundries 172
Horner, Joseph, Casting Cannon Balls in the Eighteenth Century 58
Hughes, George, Railroad Brassfounding . . 110

K

Keep, W. J., Chilled Castings from Non-Chilling Iron 60
Keep, W. J., Slagging the Cupola 27
Keep, W. J., Spongy Iron 152
Keep, W. J., Strength and Silicon 160
Keep, W. J., Strong Iron 3
Keep, W. J., Use of Silvery Iron 58
Keep, W. J., Use of Stove Plate Scrap. 102
Keep, W. J., Using a Small Cupola 171

L

Levy, Donald M., Production of Malleable Castings 11
Longmuir, Percy, Alloys of Brass and Bronze 74
Louis, H., Corrosion of Spelter Solder . . . 75
Luhrsen, Louis, Molding Bushings for Steam Cylinders 60

M

McClintock, A. E., Universal Board for Split Patterns 157
McGregor, Walter, Open-Hearth Oil-Fired Furnaces 5
Moldenke, Richard, Thin Detached Skin on Malleable Castings 158
Murphy, J. H., Description of Jarring Machine 87

P

Porter, John Jermain, Peculiar Properties of Pig Iron 137
Putnam, W. P., System in Annealing Malleable Iron 65

S

Shed, N. W., Crusher Rolls 128
Shed, N. W., Gray Iron Cylinder Mixtures 129
Shed, N. W., Shrinkage Difficulties 55
Shed, N. W., Shrinkage of Cast Iron 104
Shed, N. W., Soft Iron for Pole Shoes . . . 152
Stoughton, Bradley, Annealing of Steel Castings 7
Stoughton, Bradley, Small Steel Castings by Converter Process 9

T

Trowbridge, Amasa, Production of Die-Molded Castings 161
Tryon, W. L., Formulas for Finding the Weights of Iron Castings; Data Sheets Nos. 99 and 100, October, 1911.

V

Vaughan, William, Corrosion of Brass Foundry Products 15
Vickers, C., Deoxidizers for Copper Alloys. 154
Vickers, C., Methods of Gating Bronze Castings 13

W

Wiley, Brent, Uses of Electricity in Foundries 61
Wilson, J. J., Machine-Molded Automobile Castings 164

Data Sheets, Volume XXXIX

No. 97, September, 1911.—Deoxidizing Elements for Use in Copper and Its Alloys.
No. 98, September, 1911.—Useful Formulas for the Foundryman.
Nos. 99 and 100, October, 1911.—Formulas for Finding the Weights of Iron Castings.
Nos. 101 and 102, November, 1911.—Formulas for the Brass Foundryman.
No. 103, December, 1911.—London Tin Contract and Pig Tin Analyses.
No. 104, December, 1911.—Weights, Specific Gravities and Melting Points of Metals.